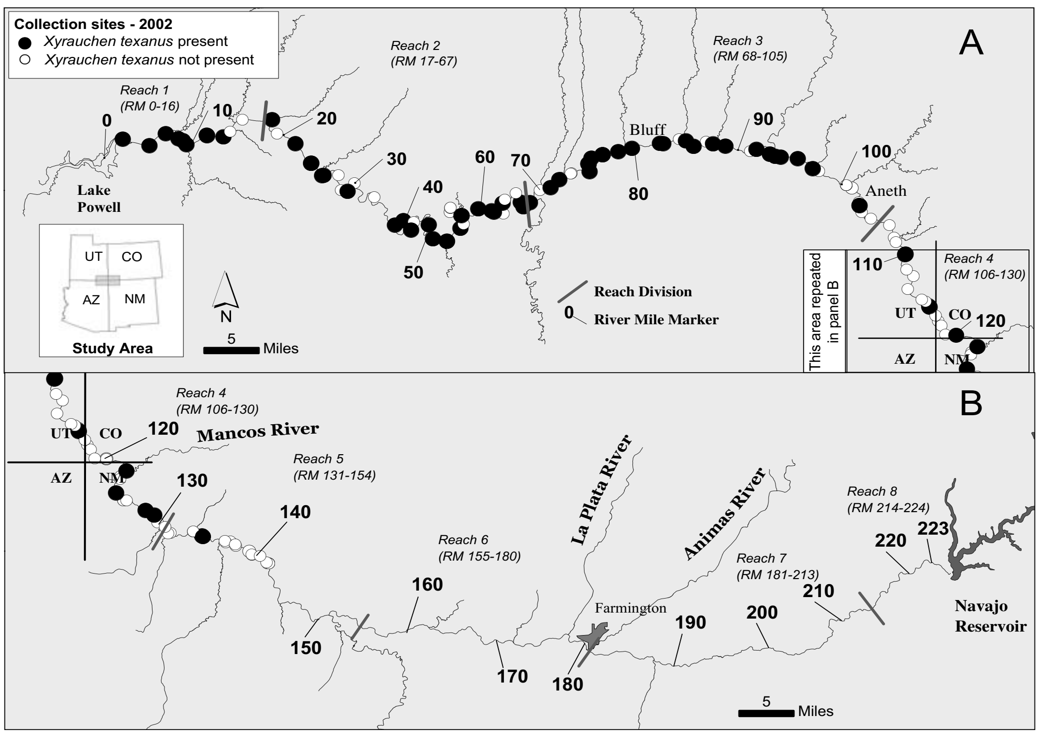
Razorback sucker larval fish survey in the San Juan River during 2002

DRAFT REPORT



W. Howard Brandenburg, Michael A. Farrington, and Sara J. Gottlieb
Division of Fishes, Museum of Southwestern Biology
Department of Biology
University of New Mexico
Albuquerque, New Mexico 87131

SAN JUAN RIVER BASIN RECOVERY IMPLEMENTATION PROGRAM

Razorback sucker larval fish survey in the San Juan River during 2002

DRAFT REPORT

prepared by:

W. Howard Brandenburg, Michael A. Farrington, and Sara J. Gottlieb
Division of Fishes, Museum of Southwestern Biology
Department of Biology
University of New Mexico
Albuquerque, New Mexico 87131

submitted to:

San Juan River Basin Biology Committee
under the authority of the
San Juan River Basin Recovery Implementation Program

31 March 2003

WARNING

************* DATA ARE PRELIMINARY *************
*********** AND SUBJECT TO CHANGE ***********

At the time of submission of this draft report (31 March 2003) on the 2002 San Juan River larval sucker survey activities there were 12 larval fish whose specific identifications had not yet been verified. Those individuals had previously been sent to the Larval Fish Laboratory at Colorado State University for specimen verification and were reported in the tables in this document as either undetermined Cyprinidae or undetermined Catostomidae. Once the final report concerning the specific identity of those fish has been completed and submitted to MSB personnel, the data will be incorporated into an updated version of this draft report and appropriate changes in species number and ichthyofaunal composition made.

************* DATA ARE PRELIMINARY *************
*********** AND SUBJECT TO CHANGE ***********

Table of Contents

List of Tables

List of Figures

Executive Summary

1. There were 152 fish collections at 139 unique sites made between river miles 141.6 and 2.8 under the 2002 razorback sucker larval fish survey.

2. The 2002 sampling effort yielded 40% fewer fish (n=56,034) as compared to 2001 (n=95,628) but still produced more fish than taken cumulatively during 1998, 1999, and 2000 (n=45,429)

3. The 152 samples resulted in the collection of fish representing six families and 11 species, with all except five samples producing fish.

4. Several species collected in 2001 were not represented in 2002 samples. Introduced fish not collected in 2002 were green sunfish, bluegill, and kokanee salmon. The native fish not collected in 2002 (nor in 2000-2001) were roundtail chub and Colorado pikeminnow.

5. Catostomids comprised 21.4% of the number of fish collected in 2002 which was a substantial increase from 2001 (8.4%)

6. Flannelmouth sucker was the numerically dominant catostomid taxon in 2002, accounting for over 63% of the sucker catch. Bluehead sucker comprised 30% of catostomids collected in 2002.

7. Introduced cyprinids comprised 72.6% (n=40,662) of the 2002 catch by number. Red shiner and fathead minnow were collected in nearly equal numeric proportions (37.2% and 34.7%, respectively) in 2002.

8. A total of 812 larval and juvenile razorback sucker was collected during the 2002 portion of this study. This is over four times as many razorback sucker as were taken in all previous years' surveys combined.

9. A total of 67 samples yielded razorback sucker, 20 of which contained >10 individuals, and five containing >50 individuals.

10. The first larval razorback sucker was collected on 29 April 2002 at RM 76.1 and the largest single sample of razorback sucker (n=91) was taken on 1 May 2002 at RM 21.2.

11. Unlike the clumped distribution of razorback sucker in 2001 collections, razorback sucker were collected throughout the study area in 2002.

12. Razorback sucker collected in 2002 included specimens that were larger than in previous years. The largest razorback sucker juvenile collected in 2002 was 62.4 mm TL as compared to 28.8 mm TL for the largest specimen taken previously.

13. In 2002, 15.9% of all razorback sucker collected were juvenile and were taken throughout the study area.

14. Larval razorback sucker (n=31) were collected in three of six light-trap sampling efforts.

Introduction

Background Information

There are few historic San Juan River records of razorback sucker, *Xyrauchen texanus*, despite that this is one of three endemic Colorado River basin catostomids native to the San Juan River drainage. Jordan (1891) conveyed anecdotal reports from the late 1800s of razorback sucker occurring in the Animas River as far upstream as Durango, Colorado. However, there were no specimens to substantiate this claim. The first verified record of razorback sucker in the San Juan River was in 1976 when two adult specimens were collected at an irrigation pond near Bluff, Utah (in VTN Consolidated, Inc., and Museum of Northern Arizona, 1978). A 1987 U.S. Bureau of Reclamation document (U.S. Bureau of Reclamation, 1987), citing personal communication from the Utah Division of Wildlife resources, reported the 1981-1984 spring occurrence of razorback sucker in the San Juan River arm of Lake Powell. The most recent San Juan River drainage occurrence of razorback sucker was the April 1988 collection of a single adult tuberculate male in the San Juan River near Bluff, Utah (Roberts and Moretti, 1989).

The extreme rarity of razorback sucker in the San Juan River drainage necessitated the experimental stocking of a small number of individuals so that information on their habitat use, potential spawning areas, and survival and growth rates could be obtained. In 1994 personnel from the U.S. Fish and Wildlife Service's Colorado River Fishery Project (CRFP; Grand Junction, Colorado) stocked the first series of razorback sucker (n=672) in the San Juan River. Those fish, whose mean length and mass at the time of stocking were about 400 mm TL and 710 g, respectively, were released between Hogback, New Mexico and Bluff, Utah. In 1995, numerous individuals from the 1994 stocking effort were recaptured including 13 tuberculate males with six of those individuals being ripe. Four razorback sucker recaptured in 1995 were determined to be female but, unlike the males, none were sexually mature. By 1996, a total of 939 razorback sucker, all of which were progeny of paired matings between San Juan River arm of Lake Powell adults, had been stocked in the San Juan River. In their 1995 report of activities, Ryden and Pfeifer (1996) suggested that the majority of experimentally stocked 1994 San Juan River razorback sucker would achieve sexual maturity by 1996 thereby providing the potential for spawning during 1997-1998. The success of the experimental stocking study resulted in the development a full-scale augmentation program for razorback sucker in the San Juan River.

At the November 1996 San Juan River Basin Biology Committee integration meeting, it was suggested that the Colorado pikeminnow, *Ptychocheilus lucius*, larval fish drift study be expanded in an attempt to document spawning of razorback sucker. The MSB-NMGF larval fish drift study, which was designed to determine spawning period, identify approximate location of spawning sites, and assess the effects of annual hydrology (and temperature) on Colorado pikeminnow reproductive activities, was also successful in providing similar information for other members of the ichthyofaunal community (i.e., longnose dace, *Rhinichthys cataractae*, and channel catfish, *Ictalurus punctatus*). However, because reproduction by razorback sucker (March-May) occurred considerably earlier than Colorado pikeminnow (June-July), separate investigations of spawning periodicity and magnitude were deemed necessary for each of the aforementioned species.

The most important difference between the established Colorado pikeminnow study and proposed razorback sucker study, besides temporal, was that the razorback sucker larval fish study was attempting to provide the first documentation of reproduction by stocked members of this species in the San Juan River. Sampling for larval razorback sucker was to be conducted with no assurance that the stocked population of adult razorback sucker would spawn in this system. Conversely, previous studies demonstrated that Colorado pikeminnow reproduction had and was still occurring in the San Juan River. This certainty allowed the Colorado pikeminnow larval fish sampling efforts to be different (i.e., monitoring) than those for razorback sucker (searching).

Numerous Upper Colorado River basin researchers identified light-traps as one of the most efficient means of collecting larval razorback sucker. The 1994-1995 National Park Service - San Juan

River fish investigation employed light-traps near the San Juan River-Lake Powell confluence as a larval fish collecting technique. That study produced a large number of larval fish (ca. 25,000 per year) from a modest number of samples (n=20). Red shiner numerically dominated (>98%) the light-trap catch during both years but neither Colorado pikeminnow nor razorback sucker were collected. The success of Upper Basin researchers and potentially large number of fish that could be collected using this technique led to the selection of light-traps as the sampling device during the first year (calendar year 1997) of San Juan River larval razorback sucker study.

Numerous locations adjacent to U.S. Hwy 163 and Utah State Hwy 262 (which paralleled the San Juan River between Aneth and Bluff) that appeared suitable for sampling with light-traps were identified during March 1997. Light-traps were set nightly in low-velocity habitats between Aneth and Mexican Hat from late March through mid-June 1997. Traps were distributed at dusk and retrieved about four hours later with any fish taken in those samples preserved in the field. Sampling success during the 1997 razorback sucker larval fish study was poor. While there were over 200 light-trap sets, those sampling efforts produced only 297 fish. Of those, about 200 (66%) were larval sucker (either flannelmouth sucker or bluehead sucker). Larval razorback sucker were not present in the 1997 sampling survey.

While there were probably several variables that accounted for the poor light-trap catch rate, a principal factor was limited access to suitable habitats. Light-traps are most effective when set in habitats with little or no water velocity. Unfortunately, increased April-June flow in the San Juan River eliminated virtually all low velocity habitats identified in March 1997. Further reconnaissance from an automobile (April - May) of the snow-melt enhanced river failed to yield additional locations suitable for light-traps. One of the results of the 1997 study was the realization that being bound to specific collecting sites was an inefficient means of collecting the large number of larval fish necessary to document reproduction of a rare species.

In 1998 the razorback sucker larval fish sampling technique was modified to allow for collections over a larger portion of the San Juan River and capture of a considerably larger number of larval fish. An inflatable raft, which was used to travel on the river, provided the opportunity to sample habitats that were formerly either inaccessible or unobservable under the constraints of the 1997 sampling protocol. Collecting trips were conducted at approximately bi-weekly intervals from mid-April until early-June along the river reach between Four Corners and Bluff. Both active and passive sampling techniques were employed to collect larval fish. The primary 1998 collecting method was sampling low-velocity habitats with a fine mesh seine. Light-traps were also employed in 1998 but set only when appropriate aquatic mesohabitats were located adjacent to that evenings' campsite. The seining technique yielded more larval sucker in a single sample than were taken cumulatively in 1997 light-trap samples. The only major change in sampling protocol between 1998 and 1999 was an expansion of the study area. In 1999 the reach of river sampled was increased from the 46 river mile reach between Four Corners to Bluff to a 123 river segment between Four Corners and Clay Hills.

The changes in sampling protocol and study reach that were instituted in 1998 proved effective. Two larval razorback sucker were collected in the San Juan River during 1998 thereby providing the first unequivocal documentation of reproduction in the San Juan River by members of a razorback sucker cohort which had been stocked as part of the San Juan River Basin Recovery Implementation Program. In 1999, seven additional larval razorback sucker were collected between river mile (RM) 96.2 (near Aneth, Utah) and RM 11.5 (near Clay Hills Crossing, Utah). The increase in the number of larval razorback sucker collected between 1998 and 1999 was probably the result of many factors including an increase in the number of stocked razorback sucker that had recruited to the adult cohort (i.e., able to reproduce). As this developmental segment (adult) of the razorback sucker population increases, so should the number and spatial distribution of collections of larval razorback sucker.

There was a dramatic increase between 1999 and 2000 in the catch of larval razorback sucker. The 2000 sampling effort produced 129 larval razorback sucker in 21 separate collections from 9 May

2000 to 2 June 2000. Razorback sucker ranged from 9.4 to 18.1 mm TL with all except one being at the mesolarval developmental stage. The apparent distribution of larval razorback sucker in 2000 expanded from RM 96.2 upstream to RM 124.8 and downstream from RM 11.5 to RM 8.1. About two-thirds of the 2000 catch of larval razorback sucker was from a single collection made on 26 May 2000 at RM 8.1 (n=86). While larval razorback sucker were generally distributed throughout the study area in 2000, they were notably rarest in the uppermost portion of the upper sampling reach.

A total of 50 larval razorback sucker was taken during the 2001 sampling effort. These collections were made between 16 May 2001 and 14 June 2001, with two being taken in light-traps on 17 May 2001. The distribution of larval razorback sucker remained the same in 2001, between RM 8.1 and RM 124.8, with the greatest numbers (>90%) being collected below Bluff, Utah. Razorback sucker collected during the first sampling trip were the smallest (10.1 to 15.5 mm TL) and least developed (all were mesolarvae) of the 2001 survey, while later collections included larger (13.0 to 28.8 mm TL) and more developed (metalarvae and juvenile) specimens.

Study Area

The San Juan River is a major tributary of the Colorado River and drains 99,200 km^2 in Colorado, New Mexico, Utah, and Arizona (Figure 1). From its origins in the San Juan Mountains of southwestern Colorado at elevations exceeding 4,250 m, the river flows westward for about 570 km before confluencing with the Colorado River. The major perennial tributaries to the San Juan River are (from upstream to downstream) Navajo, Piedra, Los Pinos, Animas, La Plata, and Mancos rivers, and McElmo Creek. In addition there are numerous ephemeral arroyos and washes that contribute relatively little flow annually but input large sediment loads.

Navajo Reservoir, completed in 1963, impounds and isolates the upper 124 km of the San Juan River and regulates downstream discharge. The completion of Glen Canyon Dam in 1966 and subsequent filling of Lake Powell ultimately inundated the lower 87 km of the San Juan River by the early 1980s. The San Juan River is now a 359 km lotic system bounded by two reservoirs (Navajo Reservoir near its head and Lake Powell at its mouth).

The San Juan River is canyon-bound and restricted to a single channel between its confluence with Chinle Creek (ca. 20 km downstream of Bluff, Utah) and Lake Powell. The river is predominately multi-channeled upstream of Chinle Creek with the highest density of secondary channels occurring between Bluff and the Hogback Diversion (ca. 13 km upstream of Shiprock, New Mexico). There is a general downstream reduction in channel stability in the section of river between Bluff and Shiprock. Below the confluence with the Animas River near Farmington, New Mexico, the channel is less stable and more subject to floods from it largest and unregulated tributary, the Animas River. Conversely, the regulated reach of river between Farmington, New Mexico and Navajo Dam is relatively stable with few secondary channels.

From Lake Powell to Navajo Dam, the mean gradient of the San Juan River is 1.67 m/km. Examined in 30 km increments, river gradient ranges from 1.24 to 2.41 m/km but locally (i.e., <30 km reaches) can be as high as 3.5 m/km. Between Shiprock and Bluff, San Juan River substrate is primarily sand mixed among some cobble. The proportion of sand is greatest in the downstream most reaches and declines along an upstream gradient. From Farmington to Navajo Dam, the San Juan River substrate is dominated by embedded cobble. Although less embedded, cobble is also the most common substrate between Shiprock and Farmington. Except in canyon-bound reaches, the river is bordered by nonnative salt cedar, *Tamarix chinensis*, and Russian olive, *Elaeagnus angustifolia*, and native cottonwood, *Populus fremontii*, and willow, *Salix* sp. Nonnative woody plants dominated nearly all sites and resulted in heavily stabilized banks. Cottonwood and willow accounted for less than 15% of the riparian vegetation.

The characteristic annual hydrographic pattern in the San Juan River is typical of rivers in the American Southwest with large flows during spring snowmelt, followed by low summer, autumn, and

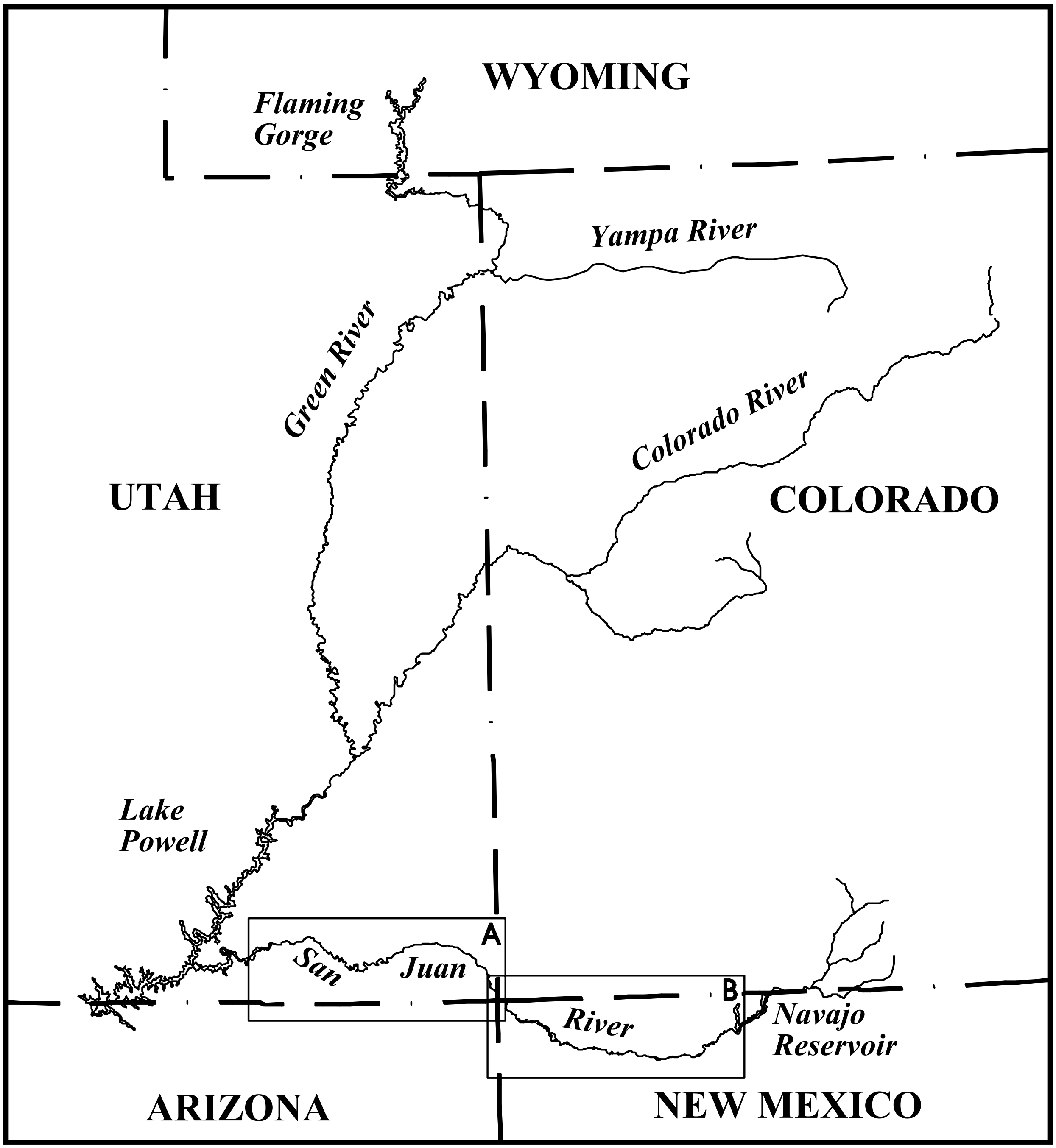


Figure 1. Location of the San Juan River within the Upper Colorado River Basin. The study area is outlined and labelled "A" and "B" with reference to subsequent maps in this report.

winter base flows. Summer and early autumn base flows are frequently punctuated by convective storm-induced flow spikes. Prior to closure of Navajo Dam, about 73% of the total annual San Juan River drainage discharge (based on USGS Gauge # 09379500; Bluff, Utah) occurred during spring runoff (1 March through 31 July). Mean daily peak discharge during spring runoff was 10,400 cfs (range = 3,810 to 33,800 cfs). Although flows resulting from summer and autumn storms contributed a comparatively small volume to total annual discharge, the magnitude of storm-induced flows exceeded the peak snowmelt discharge about 30% of the years, occasionally exceeding 40,000 cfs (mean daily discharge). Both the magnitude and frequency of these storm induced flow spikes are greater than those recorded in the Green or Colorado rivers.

Operation of Navajo Dam altered the annual discharge pattern of the San Juan River. The natural flow of the Animas River ameliorated some aspects of regulated discharge by augmenting spring discharge. Regulation resulted in reduced magnitude and increased duration of spring runoff in wet years and substantially reduced magnitude and duration of spring flow during dry years. Overall, flow regulation by operation of Navajo Dam has resulted in post-dam peak spring discharge averaging about 54% of pre-dam values. Conversely, post-dam base flow increased markedly over pre-dam base flows.

Since 1992, Navajo Dam has been operated to mimic a “natural” San Juan River hydrograph with the volume of release during spring linked to the amount of precipitation recorded during the preceding winter. Thus in years with high spring snowmelt, reservoir releases were “large” and “small” in low runoff years. Base flows since 1992 were typically greater than during pre-dam years but less than those between 1964-1991.

The primary study area for most investigations conducted under the auspices of the San Juan River Seven Year Research Program, including that reported herein, were accomplished in the mainstem San Juan River and its immediate vicinity between Navajo Dam and Lake Powell. There is considerable human activity within the floodplain of the San Juan River between Shiprock and Navajo Dam. Irrigated agriculture is practiced throughout this portion of the San Juan River Valley and adjacent uplands. Much of the river valley not devoted to agriculture (crop production and grazing) consists of small communities (e.g., Blanco and Kirtland) and several larger towns (e.g., Bloomfield and Farmington).

The Animas River Valley is similarly developed. Small portions of the river valley and uplands from Shiprock to Bluff are farmed with dispersed livestock grazing as the primary land use. In the vicinity of Montezuma Creek and Aneth, petroleum extraction occurs in the floodplain and adjacent uplands. There are few human-caused modifications of the system from Bluff to Lake Powell.

A multivariate analysis of a suite of geomorphic features of the San Juan drainage was performed to segregate the river into distinct geomorphic reaches, enhance comparison between studies, and to provide a common reference for all research. This effort (Bliesner and Lamarra, 1999) resulted in the identification of eight reaches of the San Juan River between Lake Powell and Navajo Dam. A brief characterization of each reach (from downstream to upstream) follows.

Reach 1 (RM 0 to 16, Lake Powell confluence to near Slickhorn Canyon) has been greatly influenced by fluctuating reservoir levels of Lake Powell and its backwater effect. Fine sediment (sand and silt) has been deposited to a depth of about 12 m in the lowest end of this reach since the reservoir first filled in 1980. This deposition of suspended sediment into the delta-like environment of the river/reservoir transition makes it the lowest-gradient reach in the river. This portion of the river is canyon bound with an active sand bottom. Although an abundance of low-velocity habitat is present at certain flows, it is highly ephemeral, being influenced by both river flow and Lake Powell’s elevation.

Reach 2 (RM 17 to 67, near Slickhorn Canyon to confluence with Chinle Creek) is also canyon bound but is upstream of the influence of Lake Powell. The gradient in this reach is greater than in either adjacent reach and the fourth highest in the system. The channel is primarily bedrock confined and influenced by debris fans at ephemeral tributary mouths. Riffle-type habitat dominates, and the only major rapids in the San Juan River occur in this reach. Backwater abundance is low in this reach, usually occurring in association with debris fans.

Reach 3 (RM 68 to 105, Chinle Creek to Aneth, Utah) is characterized by higher sinuosity and lower gradient (second lowest) than the other reaches, a broad floodplain, multiple channels, high island count, and high percentage of sand substrate. While this reach has the second greatest density of backwater habitats after peak spring runoff, it is extremely vulnerable to change during summer and autumn storm events. After these storm events, this reach may have the second lowest density of backwaters of the eight reaches. The active channel distributes debris piles throughout the reach following spring runoff, leading to the nickname "Debris Field".

Reach 4 (RM 107 to 130, Aneth, Utah, to below "the Mixer") is a transitional zone between the upper cobble substrate-dominated reaches and the lower sand substrate-dominated reaches. Sinuosity is moderate compared with other reaches, as is gradient. Island area is higher than in Reach 3 but lower than in Reach 5, and the valley is narrower than in either adjacent reach. Backwater habitats are low overall in this reach (third lowest among reaches) and there is little clean cobble.

Reach 5 (RM 131 to 154, the Mixer to just below Hogback Diversion) is predominantly multi-channeled with the largest total wetted area and greatest secondary channel area of any of the reaches. Secondary channels in this section tend to be longer and more stable (but fewer) than in Reach 3. Riparian vegetation is more dense in this reach than in lower reaches but less dense than in upper reaches. Cobble and gravel are more common in channel banks than sand, and clean cobble areas are more abundant than in lower reaches. Backwaters and spawning bars in this reach are much less subject to perturbation during summer and fall storm events than are the lower reaches.

Reach 6 (RM 155 to 180, below Hogback Diversion to confluence with the Animas River) is predominantly a single channel, with 50% fewer secondary channels than Reaches 3, 4, or 5. Cobble and gravel are the dominant substrata with cobble bars containing clean interstitial spaces being most abundant in this reach. There are four diversion dams that may impede fish passage in this reach. Backwater habitat abundance is low in this reach, with only Reach 2 containing fewer of these habitats. The channel has been altered by dike construction in several areas to control lateral channel movement and over-bank flow.

Reach 7 (RM 181 to 213, Animas River confluence to between Blanco and Archuleta, New Mexico) is similar to Reach 6 in terms of channel morphology. The river channel is very stable, consisting primarily of embedded cobble substrate as a result of controlled releases from Navajo Dam. In addition, much of the river bank has been stabilized and/or diked to control lateral movement of the channel and over-bank flow. Water temperature is influenced by the hypolimnetic release from Navajo Dam and is colder during the summer and warmer in the winter than that of the river below the Animas confluence.

Reach 8 (RM 213 to 224, between Blanco and Archuleta and Navajo Dam) is the most directly influenced by Navajo Dam, which is situated at its uppermost end (RM 224). This reach is primarily a single channel, with only four to eight secondary channels, depending on the flow. Cobble is the dominant substrate type, and because lateral channel movement is less confined in this reach, some loose, clean cobble sources are available from channel banks. In the upper end of the reach, just below Navajo Dam, the channel has been heavily modified by excavation of material used in dam construction. In addition, the upper 10 km of this reach above Gobernador Canyon are essentially sediment free, resulting in the clearest water of any reach. Because of Navajo Dam, this area experiences much colder summer and warmer winter water temperatures. These cool, clear water conditions have allowed development of an intensively managed blue-ribbon trout fishery to the exclusion of native species in the uppermost portion of the reach.

The study area remained the same between 2001 and 2002 and encompassed reaches 1 through 5 (Figure 2). Six razorback sucker larval fish collection trips were taken between 15 April and 28 June 2002. Three of the sampling efforts were between RM 141.6 and Bluff (RM 76.4) and three were in the lower reach. For reporting purposes, the 2002 data were separated into upper and lower reaches with the former including collections between RM 141.6 and Bluff and the latter containing collections from Bluff downstream to Clay Hills Crossing (RM 2.9).

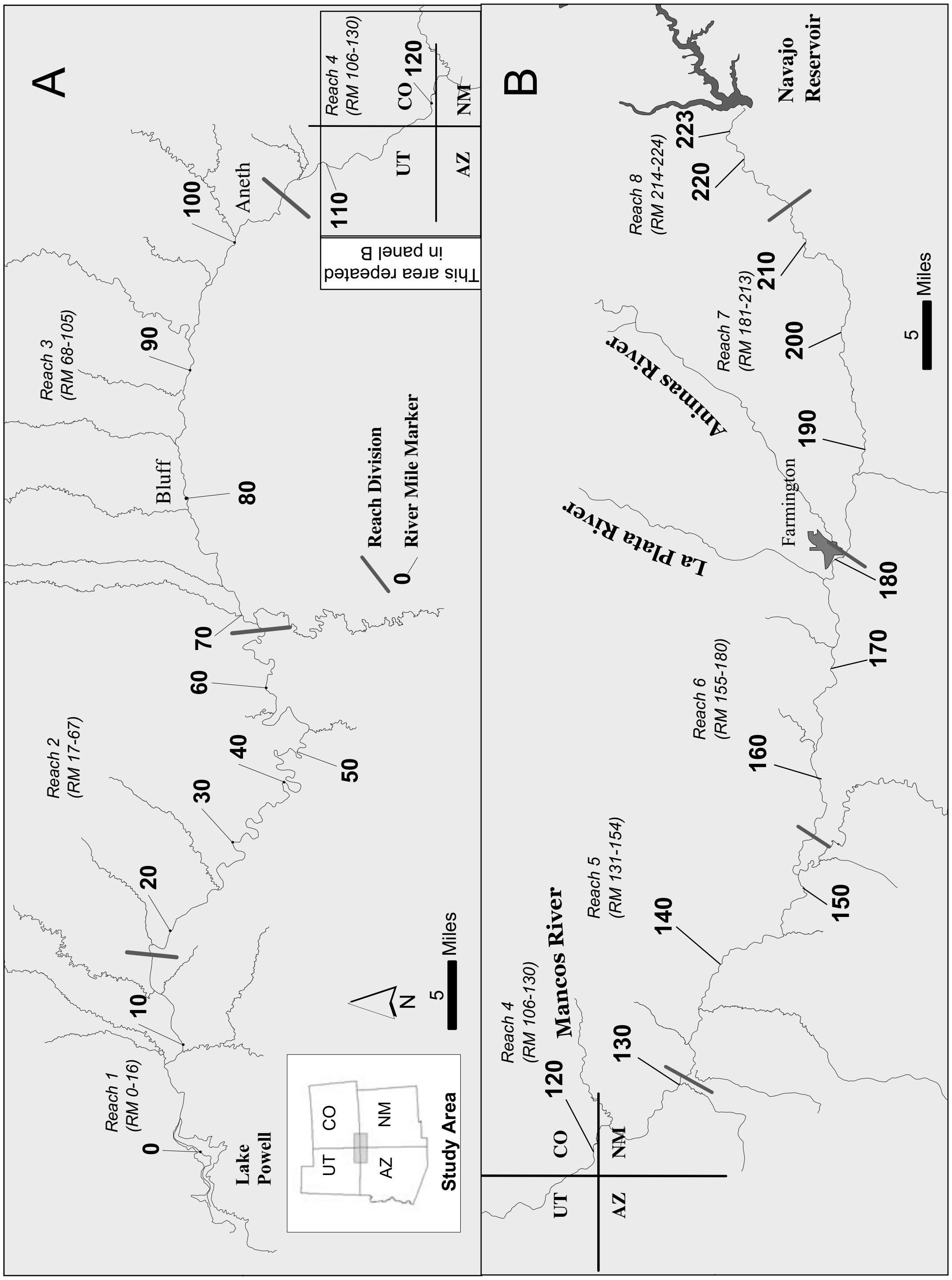


Figure 2. Map of the San Juan River study area.

A new protocol for reporting on annual monitoring activities was agreed to by the San Juan River Basin Biology Committee and initiated beginning with 2002 reports. One component of the new reporting was that data were to be presented and analyzed along the predesignated San Juan River Reaches (delineated in Study Area). This change in reporting did not work well for the larval San Juan River razorback sucker survey project as that investigation was not conducted in the same format as the other monitoring activities (i.e., small bodied fish, adult monitoring, habitat, etc). In these other well established monitoring programs, sampling of the entire river was done during a single uninterrupted effort which allowed for meaningful between-reach comparisons. Conversely, the larval San Juan River razorback sucker survey project does not attempt to sample the entire study area under a single, continuous sample event. Instead, the river was divided into functional reaches (upper and lower) based solely on the distance that could be sampled in five to seven days and points of access. The period between sampling events of the upper and lower reaches of the San Juan River (under this study) were often one to two weeks. This sampling protocol allowed for a more efficient sampling of the San Juan River, especially given that the larval San Juan River razorback sucker survey project was still functioning primarily as a "search and capture" versus "monitoring" project. Given the marked increase in the number of razorback sucker taken in 2002 and the need to formalize the sampling protocol of this project with the other monitoring surveys, beginning in 2003, the entire larval razorback sucker study area will be sampled during each individual (continuous) sampling trip.

Objectives

This work was conducted as required by the San Juan River Basin Implementation Program Monitoring Plan and Protocol dated 31 March 2000. The objectives of this specific monitoring effort are identified in the aforementioned document (1a, 3a, and 3b) and listed below:

- Determine the spawning periodicity of catostomids between mid-April and early June and examine potential correlations with temperature and discharge
- Attempt to validate the presumed spawning period of San Juan River catostomids.
- Determine if reproduction by razorback sucker occurred in the San Juan River (upstream of Mexican Hat, Utah).
- Provide a comparative analysis of the reproductive effort of catostomids
- Determine the relative annual reproductive success of razorback sucker (1a).
- Provide annual summaries of monitoring results (3a).
- Provide detailed analysis of data collected to determine progress towards endangered species recovery in three years and thence every five years (3b).

Methods

Access to the river and sampling localities was gained through the use a 16' inflatable raft that transported both personnel and collecting gear. There was not a predetermined number of samples per river mile nor geomorphic reach for this study. Instead, an effort was made to collect in as many suitable larval fish habitats as possible within the river reach being sampled. Previous San Juan River investigations have clearly demonstrated that larval fish most frequently occur and are most abundant in low velocity habitats such as pools, backwaters, and secondary channels.

Sampling efforts for larval fish concentrated on low velocity habitats using small mesh seines (1 m x 1 m x 0.8 mm) and light-traps. Meso-habitat type, length, maximum depth, and substrate were recorded for each sample. For seine samples, the length of each seine haul was determined in addition to the number of seine hauls per site. The aforementioned habitat conditions were recorded at light-trap sampling sites in addition to the time of placement and retrieval of the light-trap.

Table 1. Scientific and common names and species codes of fish collected from the San Juan River in 2002. Asterisk (*) indicates species collected in this study during previous years, but absent from 2002 samples.

Scientific Name	Common Name	Code
Order Cypriniformes		
Family Cyprinidae	carps and minnows	
Cyprinella lutrensis	red shiner	(CYPLUT)
Cyprinus carpio	common carp	(CYPCAR)
*Gila robusta**	roundtail chub	(GILROB)
Pimephales promelas	fathead minnow	(PIMPRO)
*Ptychocheilus lucius**	Colorado pikeminnow	(PTYLUC)
Rhinichthys osculus	specked dace	(RHIOSC)
Family Catostomidae	suckers	
Catostomus (Pantosteus) discobolus	bluehead sucker	(CATDIS)
Catostomus latipinnis	flannelmouth sucker	(CATLAT)
Xyrauchen texanus	razorback sucker	(XYRTEX)
Order Siluriformes		
Family Ictaluridae	bullhead catfishes	
*Ameiurus melas**	black bullhead	(AMEMEL)
Ictalurus punctatus	channel catfish	(ICTPUN)
Order Salmoniformes		
Family Salmonidae	trouts	
*Oncorhynchus nerka**	kokanee salmon	(ONCNER)
Order Atheriniformes		
Family Cyprinodontidae	killifishes	
Fundulus zebrinus	plains killifish	(FUNZEB)
Family Poeciliidae	livebearers	
Gambusia affinis	western mosquitofish	(GAMAFF)
Order Perciformes		
Family Centrarchidae	sunfishes	
*Lepomis cyanellus**	green sunfish	(LEPCYA)
*Lepomis macrochirus**	bluegill	(LEPMAC)
Micropterus salmoides	largemouth bass	(MICSAL)

All retained specimens were placed in plastic bags containing a solution of 10% formalin and a tag inscribed with unique alpha-numeric code that was also recorded on the field data sheet. Samples were returned to the laboratory where they were sorted, specimens identified to species, enumerated, measured (minimum and maximum size [mm standard length] for each species at each site), transferred to 70% ethyl alcohol, and catalogued in the Division of Fishes of the Museum of Southwestern Biology (MSB) at the University of New Mexico (UNM). Scientific and common names of fishes used in this report follow Robins et al. (1991) while six letter codes for species are those adopted by the San Juan River Basin Biology Committee (Table 1). Common names, arranged in phylogenetic order, are presented in tables in this report. For razorback sucker, a measure of total length (TL) was recorded for each individual in addition to standard length (SL). This was done in an effort to provide a higher degree of consistency and comparability with information presented from the San Juan River Basin and Upper Colorado River Basin programs. Throughout this report, length of YOY razorback sucker are presented as TL.

River Mile was determined to tenth of a mile using the 1988 aerial photos produced for the San Juan River Basin Recovery Implementation Program and used to designate the location of sampling sites. In addition, geographic coordinates were determined at each site with a Garmin Navigation Geographic Positioning System (GPS) Instrument and were recorded in Universal Transverse Mercator (UTM) Zone 12 (NAD27). In instances where coordinates could not be obtained due to poor GPS satellite signal, coordinates were determined in the lab using a Geographic Information System based on the recorded river mile.

Specimens were identified to species by MSB personnel with expertise in San Juan River Basin larval fish identification. The term young-of-year (YOY) can include both larval and juvenile fish. It refers to any fish, regardless of developmental stage, between hatching or parturition and the date (1 January) that they reach age 1 (i.e., YOY = age 0 fish). Larval fish is a specific developmental (morphogenetic) period between the time of hatching and when larval fish transform to juvenile fish. We have chosen to follow larval fish terminology as defined by Snyder (1981). There are three distinct sequential larval developmental stages: protolarvae, mesolarvae, and metalarvae. Fish in any of these developmental stages are referred to as larvae or larval fish. Juvenile fish are those that have progressed beyond the metalarval stage and no longer retain traits characteristic of larval fishes. Juveniles were classified as individuals that 1) had completely absorbed their fin folds, 2) had developed the full adult complement of rays and spines, and 3) had developed segmentation in at least a few of the rays. Specimens whose species-specific identity was questionable were forwarded to Darrel E. Snyder (Larval Fish Laboratory, Colorado State University) for review.

An electronic copy of the 2002 fish collection data was formatted and included in the San Juan River integrated database being developed at UNM.

This study was annually initiated prior to spring runoff and completed a few weeks before the cessation of spring run-off. Daily mean discharge during the study period was acquired from U.S. Geological Survey Gauge (# 09371010) at Four Corners, Colorado (Figure 3).

Results

2002 Survey

Between 15 April 2002 and 29 June 2002 a total of 152 fish collections was made at 139 unique sites in the San Juan River (Figure 4). Only five of these collections did not produce fish. Eighty-seven samples were taken in the upper reach in 2002 while 65 collections were made in the lower reach during the study period. The 152 samples resulted in the collection of over 56,000 fish representing six families and eleven species (Table 2). Introduced fish species collected in 2001 but not taken in 2002, were green sunfish, *Lepomis cyanellus*, bluegill, *Lepomis macrochirus*, and kokanee salmon, *Oncorhynchus nerka*. Roundtail chub, *Gila robusta*, and Colorado pikeminnow, both native fish species, were present in 1998

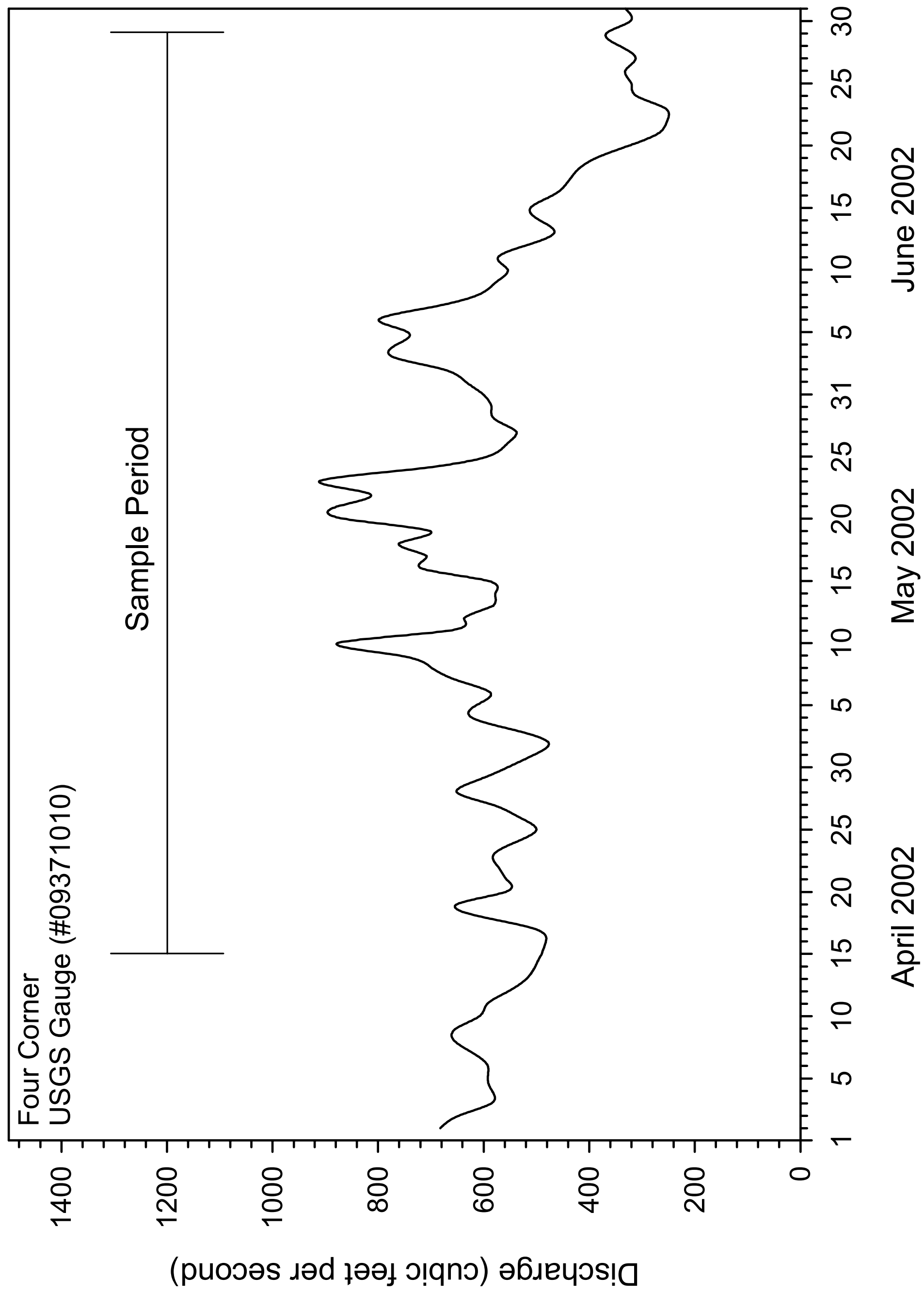


Figure 3. Hydrograph of the San Juan River at Four Corners, Colorado during the 2002 sampling period.

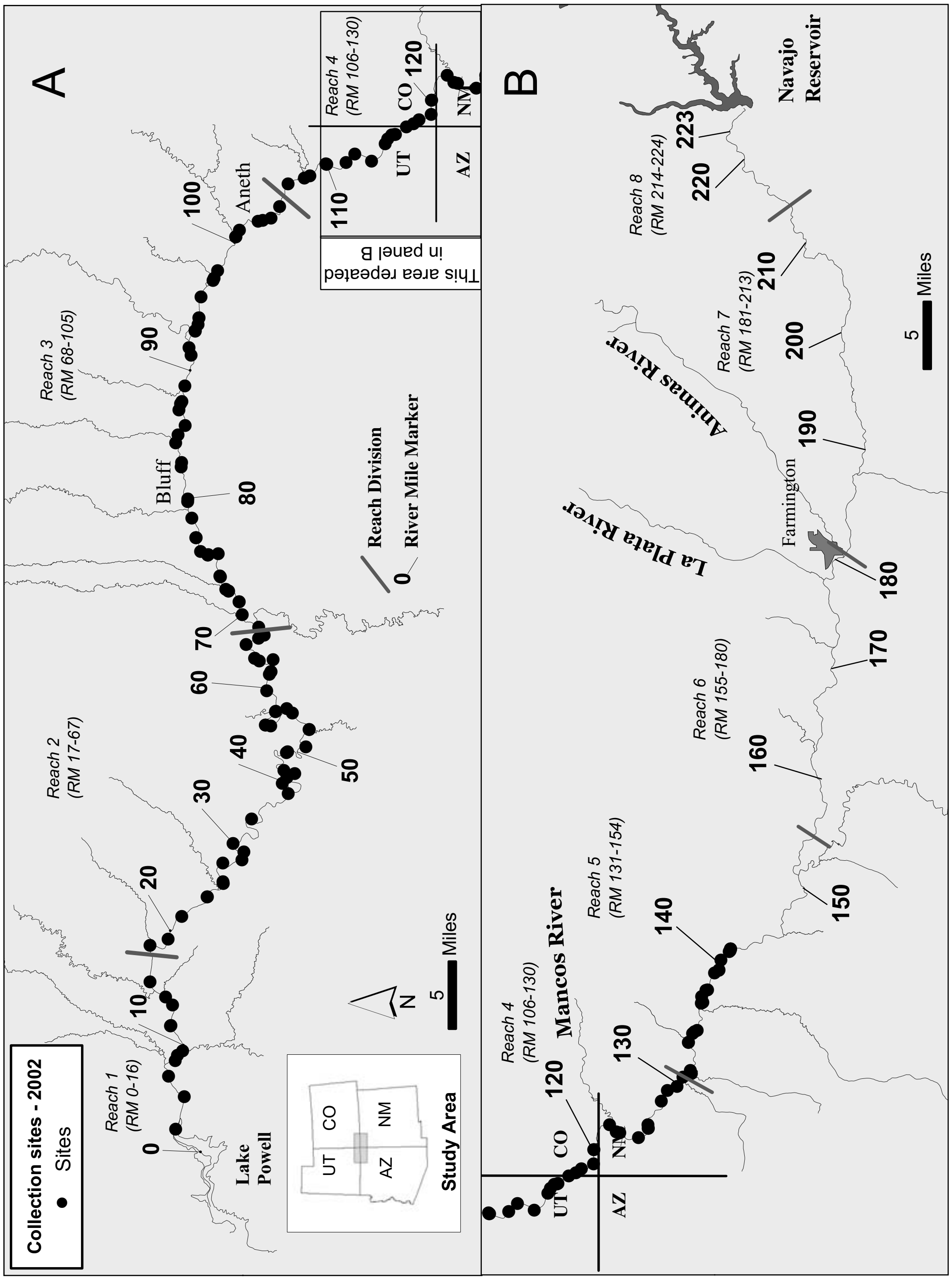


Figure 4. Map of San Juan River localities sampled during the 2002 larval razorback sucker survey.

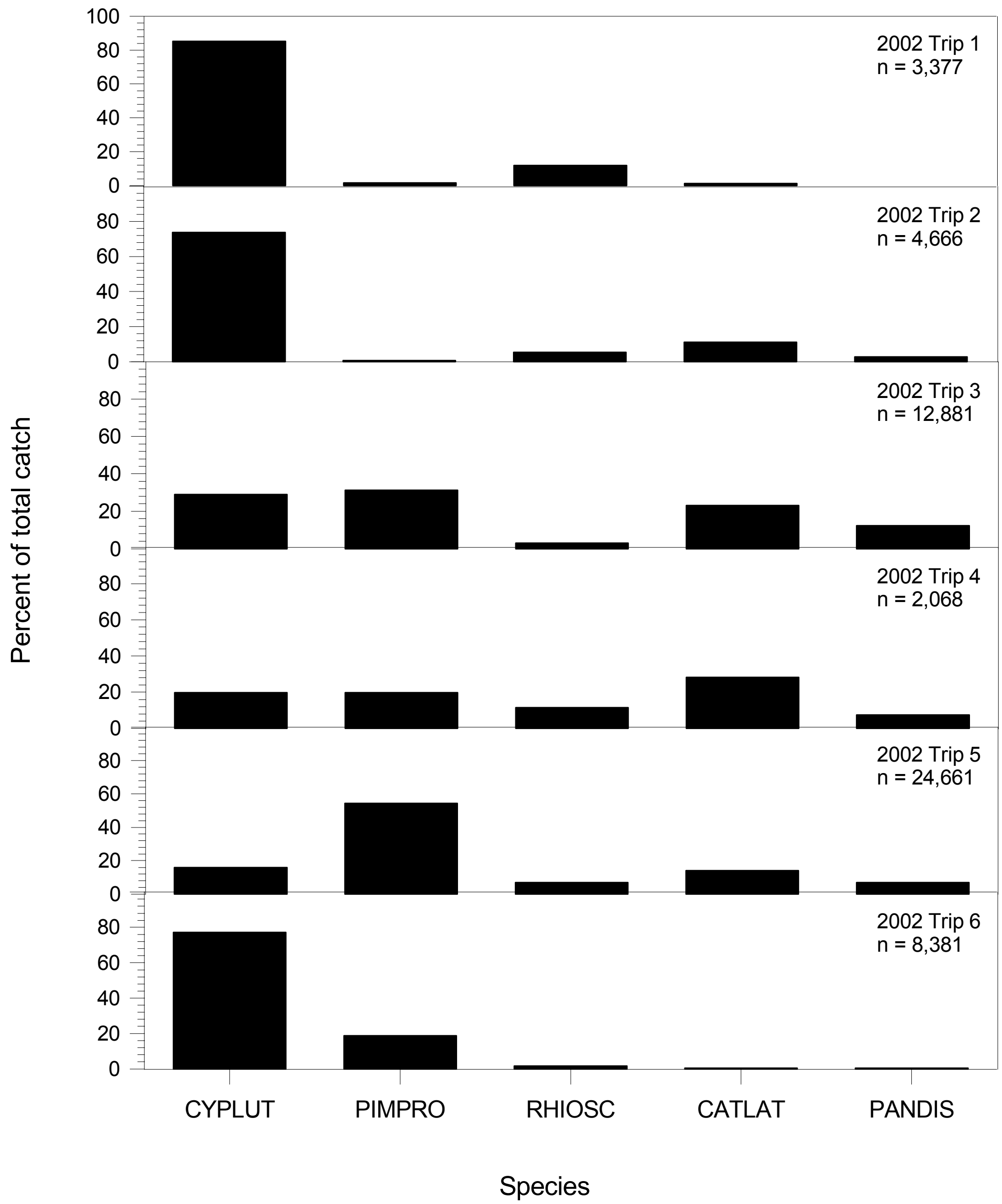


Figure 5. Ichthyofaunal composition of the most abundant species in 2002 sampling efforts by trip.

Table 2. Summary of 2002 San Juan River larval razorback sucker project fish collections.

SPECIES	RESIDENCE STATUS[1]	TOTAL NUMBER OF SPECIMENS	PERCENT OF TOTAL	FREQUENCY OF OCCURRENCE[2]	% FREQUENCY OF OCCURRENCE[2]
CARPS AND MINNOWS					
red shiner	I	20,866	37.2	127	83.6
common carp	I	338	0.6	25	16.5
roundtail chub	N	-	-	-	-
fathead minnow	I	19,458	34.7	94	61.8
Colorado pikeminnow	N	-	-	-	-
speckled dace	N	3,136	5.6	111	73.0
undetermined Cyprinidae		1	-	1	0.7
SUCKERS					
flannelmouth sucker	N	7,588	13.5	112	73.7
bluehead sucker	N	3,589	6.4	97	63.8
razorback sucker	N	812	1.5	67	44.1
undetermined Catostomidae		11	*	7	4.6
BULLHEAD CATFISHES					
black bullhead	I	-	-	-	-
channel catfish	I	2	*	2	1.3
KILLIFISHES					
plains killifish	I	111	0.2	9	5.9
LIVEBEARERS					
western mosquitofish	I	103	0.2	28	18.4
SUNFISHES					
green sunfish	I	-	-	-	-
bluegill	I	-	-	-	-
largemouth bass	I	19	*	8	5.3
TOTAL		56,034			

1 N = native; I = introduced
2 Frequency and % frequency of occurrence are based on n=152 samples.

* Value <0.05%

Table 3. Summary of 2002 San Juan River larval razorback sucker project light-trap collections.

SPECIES	RESIDENCE STATUS[1]	TOTAL NUMBER OF SPECIMENS	PERCENT OF TOTAL	FREQUENCY OF OCCURRENCE[2]	% FREQUENCY OF OCCURRENCE[2]
CARPS AND MINNOWS					
red shiner	I	1,034	13.1	4	66.7
common carp	I	31	0.4	2	33.3
roundtail chub	N	-	-	-	-
fathead minnow	I	6,329	80.4	5	83.3
Colorado pikeminnow	N	-	-	-	-
speckled dace	N	186	2.4	4	66.7
undetermined Cyprinidae		-	-	-	-
SUCKERS					
flannelmouth sucker	N	31	0.4	3	50.0
bluehead sucker	N	223	2.8	4	66.7
razorback sucker	N	31	0.4	3	50.0
undetermined Catostomidae		-	-	-	-
BULLHEAD CATFISHES					
black bullhead	I	-	-	-	-
channel catfish	I	-	-	-	-
KILLIFISHES					
plains killifish	I	-	-	-	-
LIVEBEARERS					
western mosquitofish	I	6	0.1	3	50.0
SUNFISHES					
green sunfish	I	-	-	-	-
bluegill	I	-	-	-	-
largemouth bass	I	-	-	-	-
TOTAL		7,871			

1 N = native; I = introduced

2 Frequency and % frequency of occurrence are based on n=6 samples.

Table 4. Summary of 2002 San Juan River larval razorback sucker project fish collections in the upper portion of the study area (between Cudei, New Mexico and Bluff, Utah).

SPECIES	RESIDENCE STATUS[1]	TOTAL NUMBER OF SPECIMENS	PERCENT OF TOTAL	FREQUENCY OF OCCURRENCE[2]	% FREQUENCY OF OCCURRENCE[2]
CARPS AND MINNOWS					
red shiner	I	10,554	25.8	69	79.3
common carp	I	262	0.6	18	20.7
roundtail chub	N	-	-	-	-
fathead minnow	I	17,453	42.7	55	63.2
Colorado pikeminnow	N	-	-	-	-
speckled dace	N	2,509	6.1	68	78.2
undetermined Cyprinidae		1	*	1	1.15
SUCKERS					
flannelmouth sucker	N	6,457	15.8	59	67.8
bluehead sucker	N	3,265	8.0	56	64.4
razorback sucker	N	242	0.6	27	31.0
undetermined Catostomidae		6	-	4	4.6
BULLHEAD CATFISHES					
black bullhead	I	-	-	-	-
channel catfish	I	-	-	-	-
KILLIFISHES					
plains killifish	I	110	0.3	7	8.1
LIVEBEARERS					
western mosquitofish	I	48	0.1	15	17.2
SUNFISHES					
green sunfish	I	-	-	-	-
bluegill	I	-	-	-	-
largemouth bass	I	12	*	5	5.8
TOTAL		40,919			

[1] N = native; I = introduced
[2] Frequency and % frequency of occurrence are based on n=87 samples.

* Value <0.05%

Table 5. Summary of 2002 San Juan River larval razorback sucker project fish collections in the lower portion of the study area (between Bluff and Clay Hills, Utah).

SPECIES	RESIDENCE STATUS[1]	TOTAL NUMBER OF SPECIMENS	PERCENT OF TOTAL	FREQUENCY OF OCCURRENCE[2]	% FREQUENCY OF OCCURRENCE[2]
CARPS AND MINNOWS					
red shiner	I	10,312	68.2	58	89.2
common carp	I	76	0.5	7	10.8
roundtail chub	N	-	-	-	-
fathead minnow	I	2,005	13.3	39	60.0
Colorado pikeminnow	N	-	-	-	-
speckled dace	N	627	4.2	43	66.2
undetermined Cyprinidae		-	-	-	-
SUCKERS					
flannelmouth sucker	N	1,131	7.5	53	81.5
bluehead sucker	N	324	2.1	41	63.1
razorback sucker		570	3.8	40	61.5
undetermined Catostomidae		5	*	3	4.6
BULLHEAD CATFISHES					
black bullhead	I	-	-	-	-
channel catfish	I	2	*	2	3.1
KILLIFISHES					
plains killifish	I	1	*	1	1.5
LIVEBEARERS					
western mosquitofish	I	55	0.4	12	18.5
SUNFISHES					
green sunfish	I	-	-	-	-
bluegill	I	-	-	-	-
largemouth bass	I	7	*	3	4.6
TOTAL		15,115			

[1] N = native; I = introduced

[2] Frequency and % frequency of occurrence are based on n=65 samples.

* Value <0.05%

and1999 samples but have not been collected (during this project) since that time. While there was about a 40% decrease in the total number of fish collected in 2002 (n=56,034) as compared to 2001 (n=95,628), 2002 collections still produced more fish than had been taken cumulatively during 1998, 1999, and 2000 (n=45,429). The largest number of specimens were taken during trips 3 (n= 12,881) and 5 (n= 24,661), both of which were in the upper reach of the study area.

Catostomids comprised 21.4% of fish collected in 2002 compared to 8.4% in 2001. Flannelmouth sucker, *Catostomus latipinnis*, was the numerically dominant catostomid during 2002 accounting for over 63.2% of the sucker catch (Figure 5). As has been documented annually since 1998, flannelmouth sucker was the first catostomid to spawn in 2002. Forty larval flannelmouth sucker specimens (protolarvae and mesolarvae) were collected, in four separate collections during the first upper reach trip (15-19 April 2002). The four collections that contained larval flannelmouth sucker were from Reach 3 in the area from just upstream of Montezuma Creek to Bluff, Utah. About 85% of all larval flannelmouth sucker were taken in the upper reaches (Reaches 3 - 5) of the study area.

Bluehead sucker, *Catostomus discobolus*, comprised 30.0% of the total number of catostomids collected during this study in 2002. This was a ten-fold increase in the number of larval bluehead sucker taken between 2001 and 2002. A disproportionate majority (91.0%) of larval bluehead sucker taken during 2002 were collected in the upper reaches of the study area (Reaches 3-5).

The greatest increase, between 2001 and 2002, in sucker abundance was recorded in razorback sucker. There was a sixteen-fold increase in the number of razorback sucker collected in 2002 (n=812; Table 2) versus 2001 with YOY individuals being collected throughout the study area. Unlike flannelmouth sucker and bluehead sucker, razorback sucker was more abundant in lower (Reaches 1- 3) than upper river reaches (4 and 5). Reach 5 produced the fewest YOY razorback sucker (n=1) while the largest number of specimens of this species (n=338, 42%) were taken in Reach 2.

Introduced cyprinids comprised 72.6% of the 2002 catch. Although red shiner, *Cyprinella lutrensis*, was the most abundant fish taken in 2002, it was not as numerically dominant (37.2%) as during 2001 (87.3%). It was noteworthy that the 2002 catch of fathead minnow, *Pimephales promelas*, nearly equaled that of red shiner. Red shiner catch was nearly identical between reaches, while 89.7% of fathead minnow were collected in the upper portion of the study area .

Light-traps were employed at six sampling sites during the 2002 larval razorback survey. All sites sampled with light traps were in the upper reach with total of 26 light-traps set. This was the fewest occasions that light-traps were used since 1998. The low frequency of light-trap use was due to the relative scarcity of suitable backwater habitats during 2002. Light-trap collections accounted for 14% of the total 2002 catch (n= 7,871) with fathead minnow and red shiner comprising 93.5% of the light-trap catch. Catostomids were 3.6% (n=285) of the total number of specimens taken in light-traps with razorback sucker (n=31) being 10.9% of the sucker light-trap catch. This was the third year (of five) in which larval razorback sucker were collected in light-traps in the San Juan River.

There were more collections in the upper reach of the study area (n=87) than in the lower reach (n=65) due, in part, to the early termination of sampling effort six (a lower reach trip). Discharge in the river became too low (<300 cfs) during the final sampling effort (27-29 June 2002) to allow travel in inflatable rafts. A total of 3,512.3 m^2 was sampled in the upper reach and 2,854.3 m^2 in the lower reach. There were notable between reach differences in the number of fish collected with the upper reach (Reaches 3-5) producing 73% of the total 2002 catch (Tables 4 and 5). Speckled dace, *Rhinichthys osculus*, and catostomids were more common in the upper reach, constituting 80% and 83% of the total catch of those taxa, respectively.

The first 2002 sampling effort occurred in the upper reach from 15-19 April 2002 (Figure 6) and yielded the second smallest number of fish taken during this study. Red shiner numerically dominated the collections comprising 85.3% of total fish collected (Table 6). None of the red shiner were larval fish. The first larval catostomid (flannelmouth sucker) was collected on 18 April 2002 two river miles upstream of Montezuma Creek.

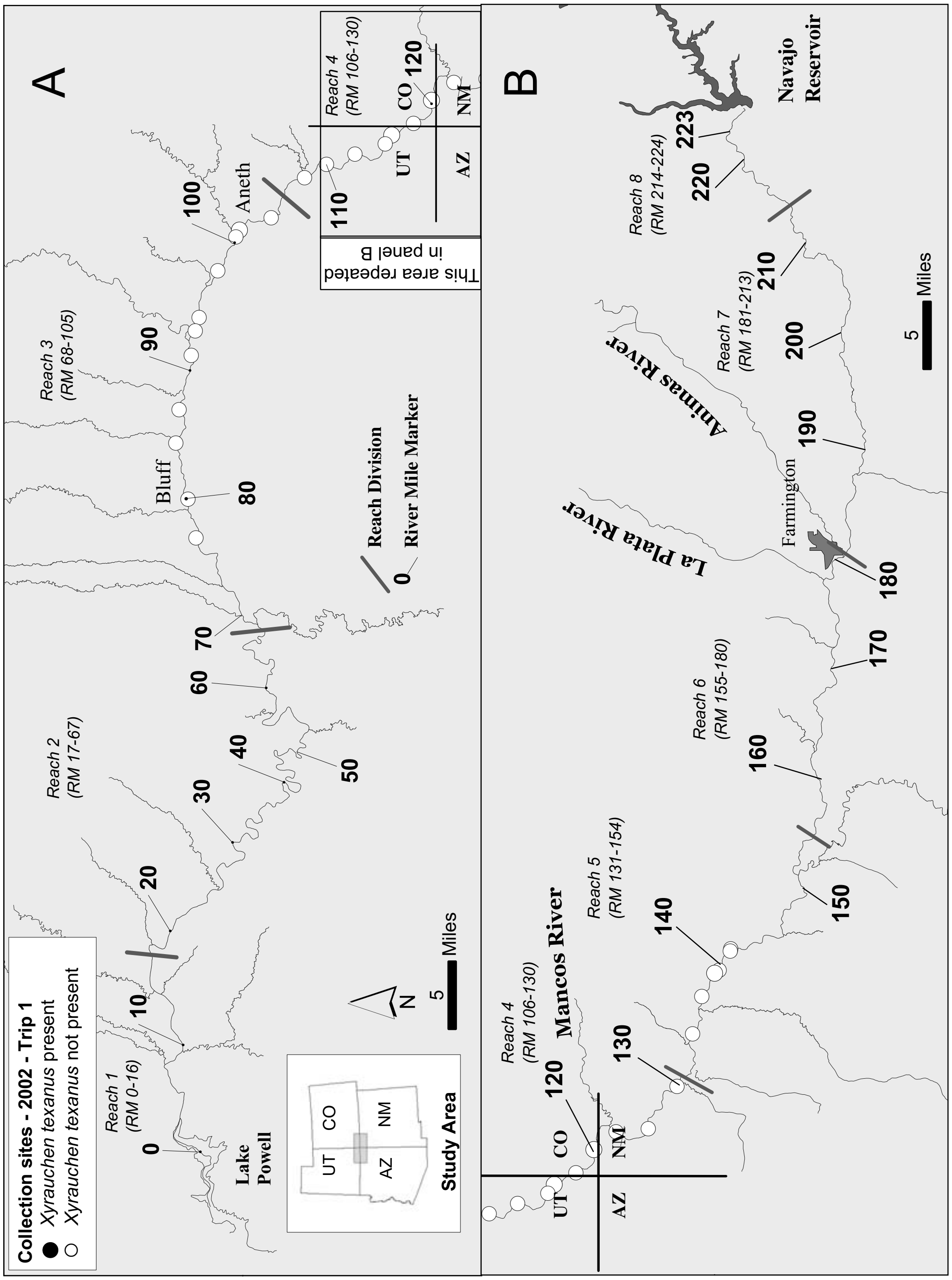


Figure 6. Map of localities sampled during the 1st 2002 San Juan River larval razorback sucker project fish collection (15-19 April 2002; Cudei to Bluff). There were no razorback sucker collected.

Table 6. Summary of the 1st 2002 San Juan River larval razorback sucker project fish collection (15-19 April 2002; Cudei to Bluff).

SPECIES	RESIDENCE STATUS[1]	TOTAL NUMBER OF SPECIMENS	PERCENT OF TOTAL	FREQUENCY OF OCCURRENCE[2]	% FREQUENCY OF OCCURRENCE[2]
CARPS AND MINNOWS					
red shiner	I	2,882	85.3	19	70.4
common carp	I	-	-	-	-
roundtail chub	N	-	-	-	-
fathead minnow	I	51	1.5	8	29.6
Colorado pikeminnow	N	-	-	-	-
speckled dace	N	402	11.9	15	55.6
undetermined Cyprinidae		-	-	-	-
SUCKERS					
flannelmouth sucker	N	40	1.2	4	14.8
bluehead sucker	N	-	-	-	-
razorback sucker	N	-	-	-	-
undetermined Catostomidae		-	-	-	-
BULLHEAD CATFISHES					
black bullhead	I	-	-	-	-
channel catfish	I	-	-	-	-
KILLIFISHES					
plains killifish	I	1	*	2	7.4
LIVEBEARERS					
western mosquitofish	I	1	*	2	7.4
SUNFISHES					
green sunfish	I	-	-	-	-
bluegill	I	-	-	-	-
largemouth bass	I	-	-	-	-
TOTAL		3,377			

[1] N = native; I = introduced
[2] Frequency and % frequency of occurrence are based on n=27 samples.

* Value <0.05%

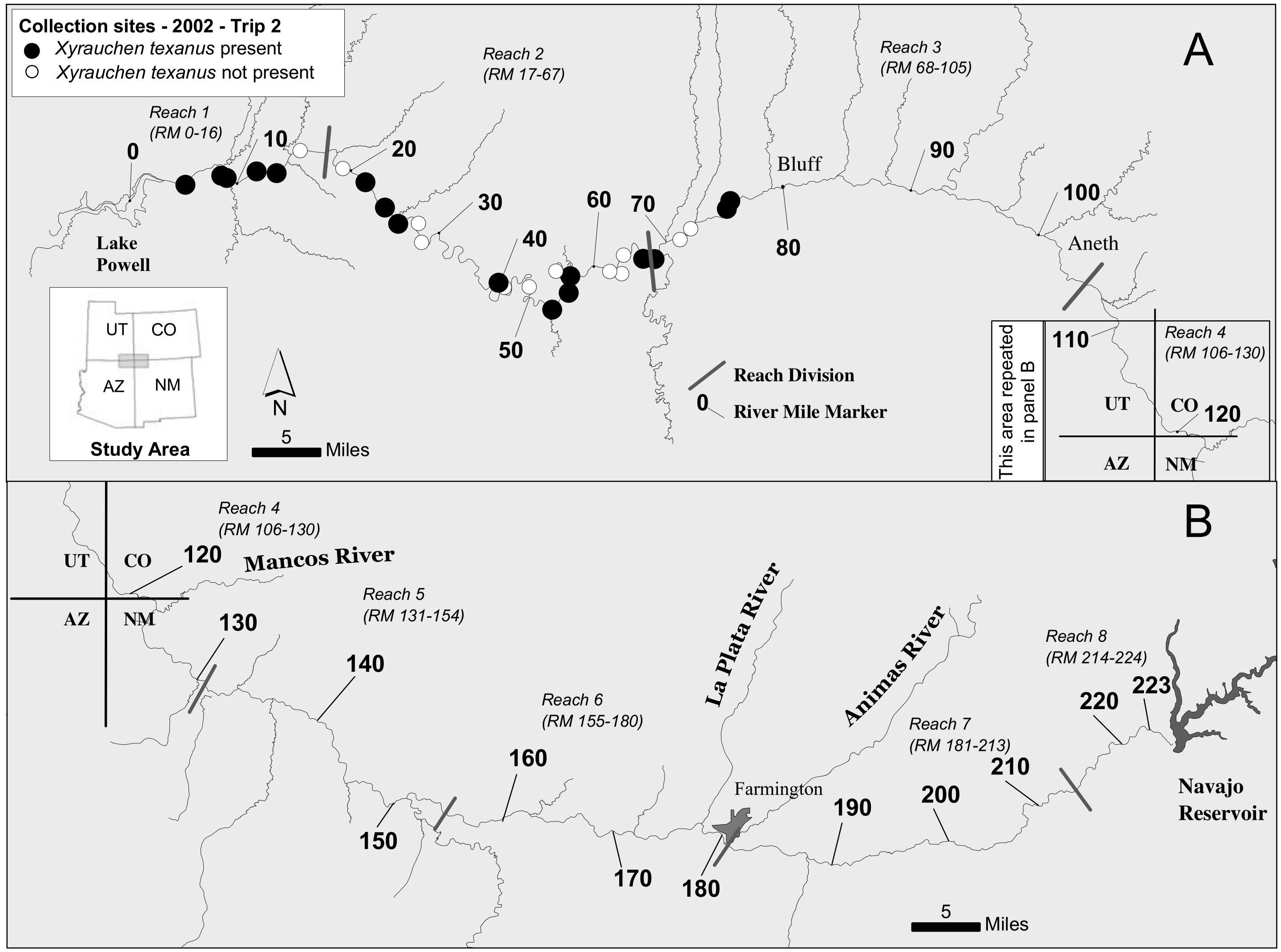


Figure 7. Map of localities sampled during the 2nd 2002 San Juan River larval razorback sucker project fish collection (29 April - 2 May 2002; Bluff to Clay Hills).

Table 7. Summary of the 2nd 2002 San Juan River larval razorback sucker project fish collection (29 April - 2 May 2002; Bluff to Clay Hills).

SPECIES	RESIDENCE STATUS[1]	TOTAL NUMBER OF SPECIMENS	PERCENT OF TOTAL	FREQUENCY OF OCCURRENCE[2]	% FREQUENCY OF OCCURRENCE[2]
CARPS AND MINNOWS					
red shiner	I	3,439	73.7	26	92.9
common carp	I	-	-	-	-
roundtail chub	N	-	-	-	-
fathead minnow	I	31	0.7	13	46.4
Colorado pikeminnow	N	-	-	-	-
speckled dace	N	249	5.3	16	57.1
undetermined Cyprinidae		-	-	-	-
SUCKERS					
flannelmouth sucker	N	519	11.1	27	96.4
bluehead sucker	N	129	2.8	17	60.7
razorback sucker	N	296	6.3	16	57.1
undetermined Catostomidae		2	*	1	3.6
BULLHEAD CATFISHES					
black bullhead	I	-	-	-	-
channel catfish	I	-	-	-	-
KILLIFISHES					
plains killifish	I	1	*	1	3.6
LIVEBEARERS					
western mosquitofish	I	-	-	-	-
SUNFISHES					
green sunfish	I	-	-	-	-
bluegill	I	-	-	-	-
largemouth bass	I	-	-	-	-
TOTAL		4,666			

1 N = native; I = introduced
2 Frequency and % frequency of occurrence are based on n=28 samples.

* Value <0.05%

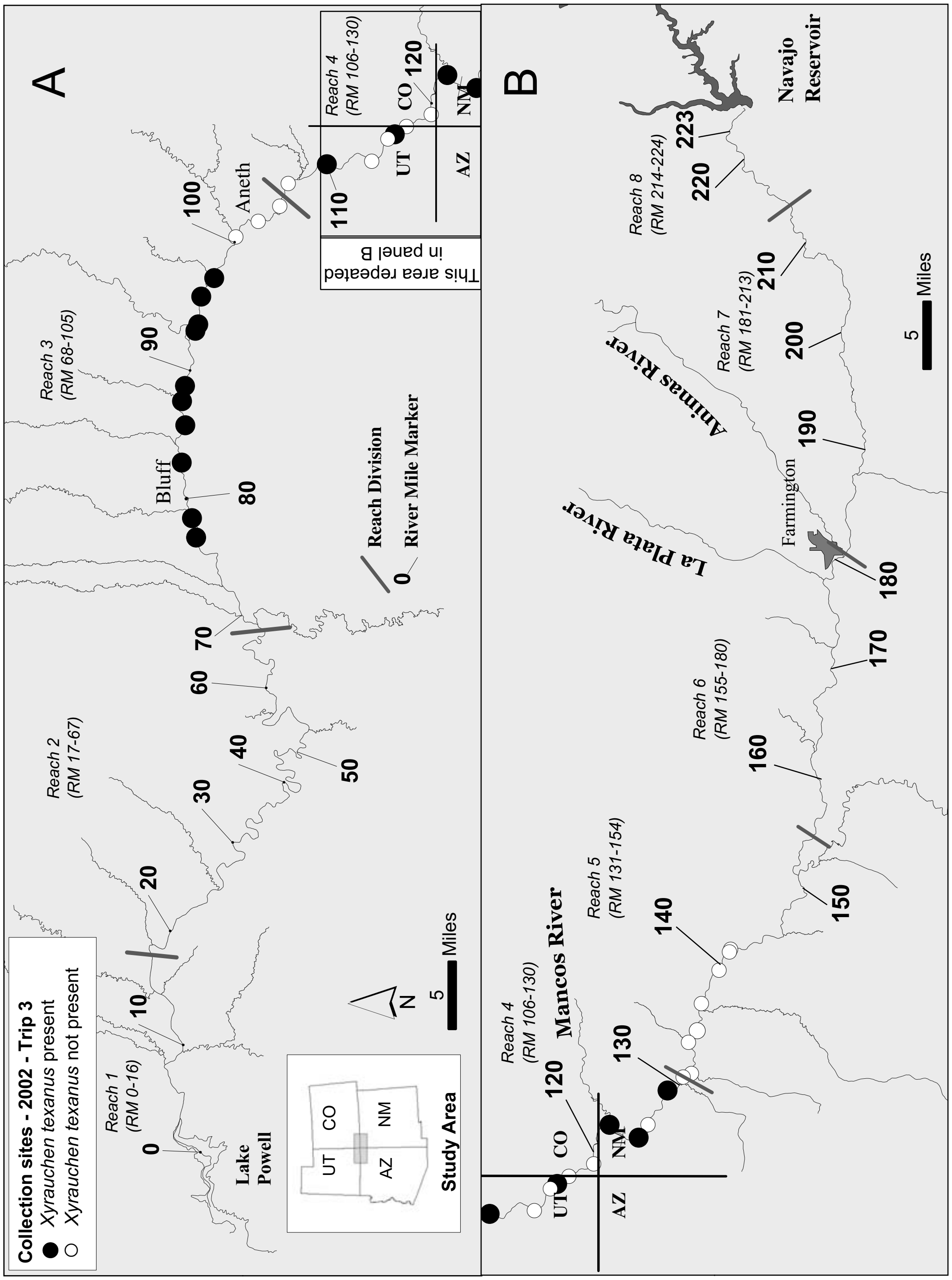


Figure 8. Map of localities sampled during the 3rd 2002 San Juan River larval razorback sucker project fish collection (15-19 May 2002; Cudei to Bluff).

Table 8. Summary of the 3rd 2002 San Juan River larval razorback sucker project fish collection (15-19 May 2002; Cudei to Bluff).

SPECIES	RESIDENCE STATUS[1]	TOTAL NUMBER OF SPECIMENS	PERCENT OF TOTAL	FREQUENCY OF OCCURRENCE[2]	% FREQUENCY OF OCCURRENCE[2]
CARPS AND MINNOWS					
red shiner	I	3,734	29.0	23	71.9
common carp	I	-	-	-	-
roundtail chub	N	-	-	-	-
fathead minnow	I	4,029	31.3	19	59.4
Colorado pikeminnow	N	-	-	-	-
speckled dace	N	388	3.0	25	78.1
undetermined Cyprinidae		1	*	1	3.1
SUCKERS					
flannelmouth sucker	N	2,969	23.1	29	90.6
bluehead sucker	N	1,580	12.3	28	87.5
razorback sucker	N	133	1.0	15	46.9
undetermined Catostomidae		4	*	2	6.3
BULLHEAD CATFISHES					
black bullhead	I	-	-	-	-
channel catfish	I	-	-	-	-
KILLIFISHES					
plains killifish	I	34	0.3	3	9.4
LIVEBEARERS					
western mosquitofish	I	9	0.1	5	15.6
SUNFISHES					
green sunfish	I	-	-	-	-
bluegill	I	-	-	-	-
largemouth bass	I	-	-	-	-
TOTAL		12,881			

[1] N = native; I = introduced
[2] Frequency and % frequency of occurrence are based on n=32 samples.

* Value <0.05%

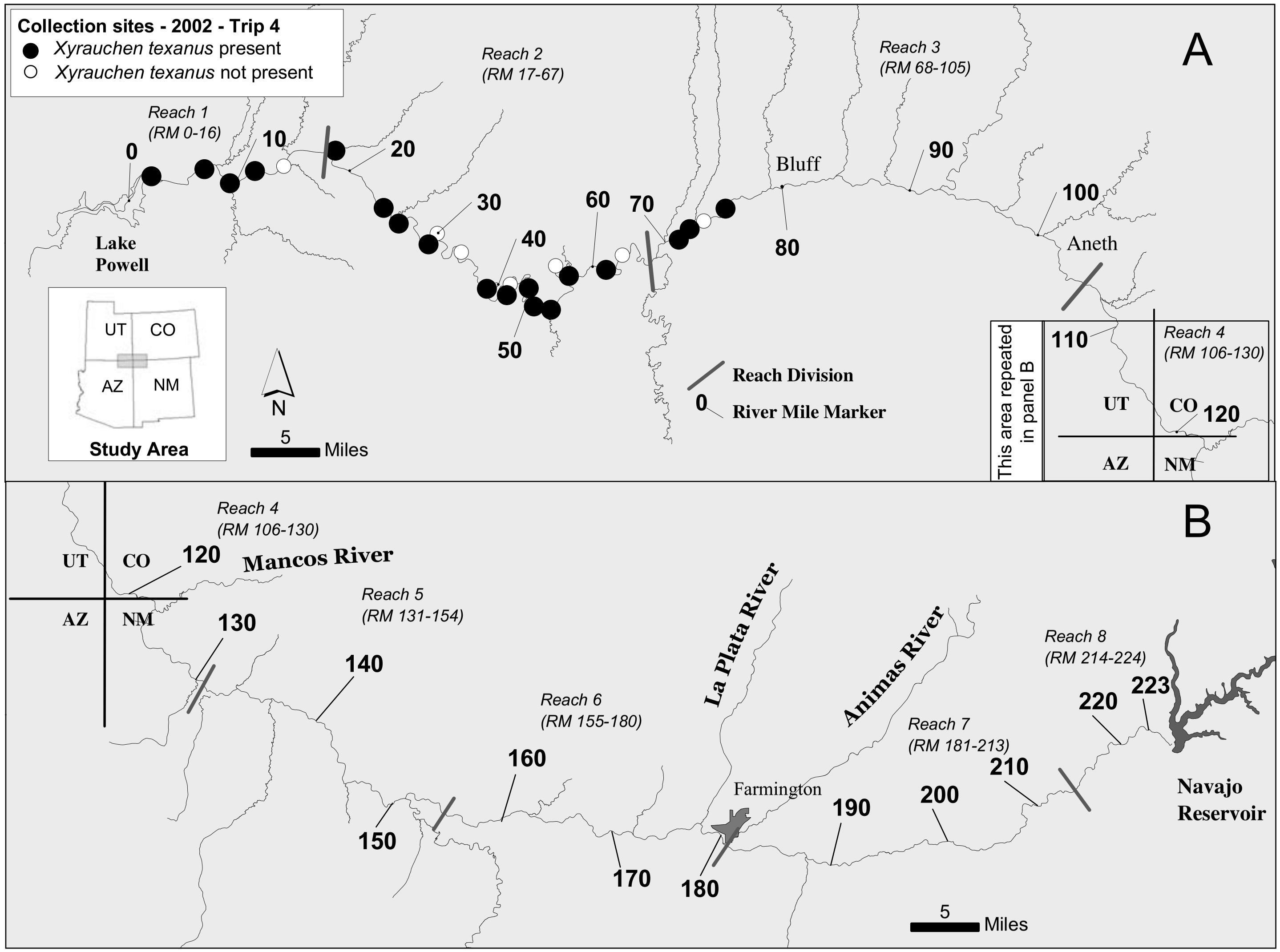


Figure 9. Map of localities sampled during the 4th 2002 San Juan River larval razorback sucker project fish collection (29 May - 1 June 2002; Bluff to Clay Hills).

Table 9. Summary of the 4th 2002 San Juan River larval razorback sucker project fish collection (29 May - 1 June 2002; Bluff to Clay Hills).

SPECIES	RESIDENCE STATUS[1]	TOTAL NUMBER OF SPECIMENS	PERCENT OF TOTAL	FREQUENCY OF OCCURRENCE[2]	% FREQUENCY OF OCCURRENCE[2]
CARPS AND MINNOWS					
red shiner	I	408	19.7	21	84.0
common carp	I	-	-	-	-
roundtail chub	N	-	-	-	-
fathead minnow	I	408	19.7	14	56.0
Colorado pikeminnow	N	-	-	-	-
speckled dace	N	240	11.6	17	68.0
undetermined Cyprinidae		-	-	-	-
SUCKERS					
flannelmouth sucker	N	583	28.2	18	72.0
bluehead sucker	N	155	7.5	14	56.0
razorback sucker	N	259	12.5	18	72.0
undetermined Catostomidae		3	0.2	2	8.0
BULLHEAD CATFISHES					
black bullhead	I	-	-	-	-
channel catfish	I	1	*	1	4.0
KILLIFISHES					
plains killifish	I	-	-	-	-
LIVEBEARERS					
western mosquitofish	I	11	0.5	3	12.0
SUNFISHES					
green sunfish	I	-	-	-	-
bluegill	I	-	-	-	-
largemouth bass	I	-	-	-	-
TOTAL		2,068			

[1] N = native; I = introduced
[2] Frequency and % frequency of occurrence are based on n=25 samples.

* Value <0.05%

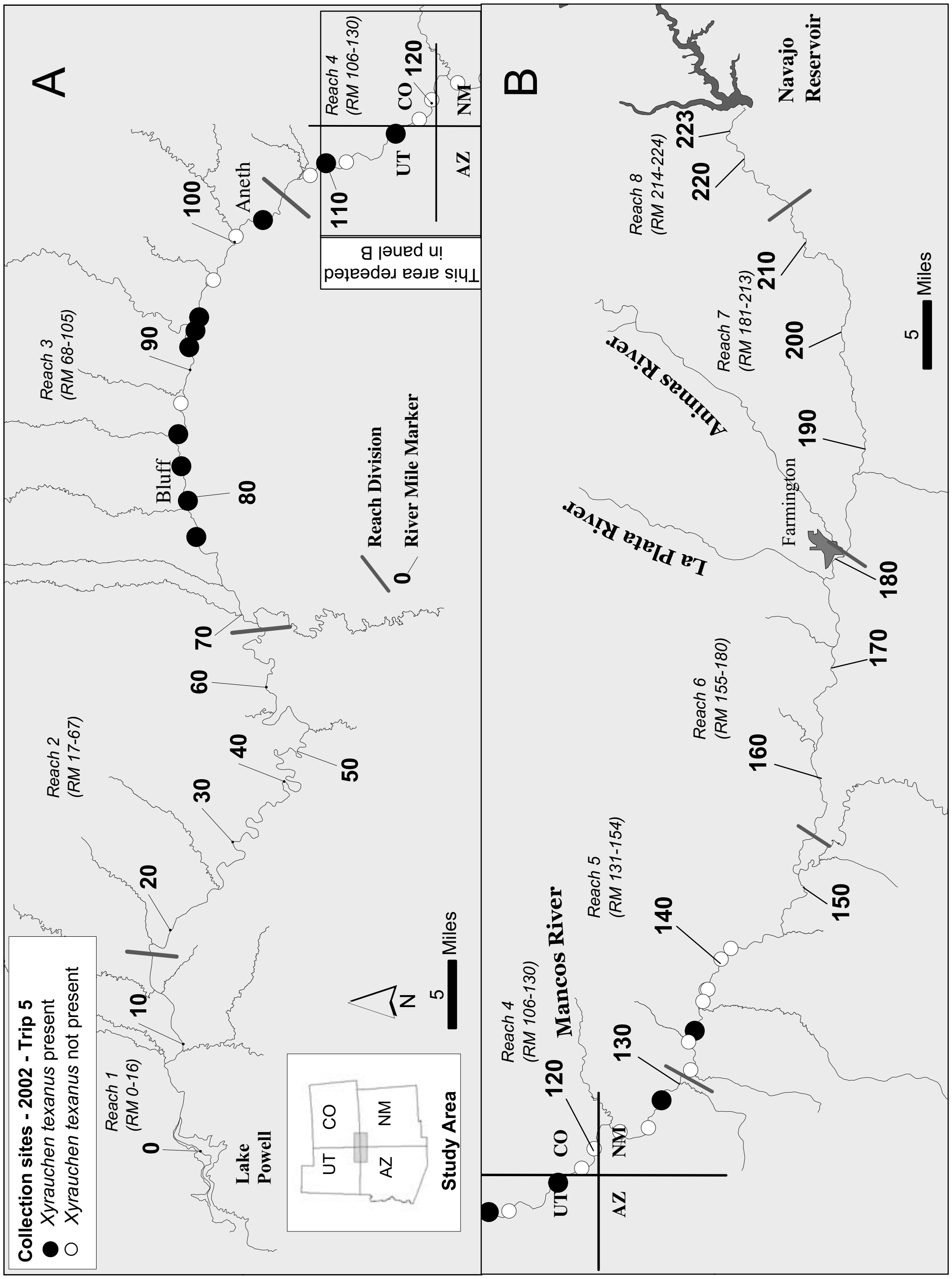


Figure 10. Map of localities sampled during the 5th 2002 San Juan River larval razorback sucker project fish collection (10-13 June 2002; Cudei to Bluff).

Table 10. Summary of the 5th 2002 San Juan River larval razorback sucker project fish collection (10-13 June 2002; Cudei to Bluff).

SPECIES	RESIDENCE STATUS[1]	TOTAL NUMBER OF SPECIMENS	PERCENT OF TOTAL	FREQUENCY OF OCCURRENCE[2]	% FREQUENCY OF OCCURRENCE[2]
CARPS AND MINNOWS					
red shiner	I	3,938	16.0	27	96.4
common carp	I	262	1.1	18	64.3
roundtail chub	N	-	-	-	-
fathead minnow	I	13,373	54.2	28	100.0
Colorado pikeminnow	N	-	-	-	-
speckled dace	N	1,719	7.0	28	100.0
undetermined Cyprinidae		-	-	-	-
SUCKERS					
flannelmouth sucker	N	3,448	14.0	26	92.9
bluehead sucker	N	1,685	6.8	28	100.0
razorback sucker	N	109	0.4	12	42.9
undetermined Catostomidae		2	*	2	7.1
BULLHEAD CATFISHES					
black bullhead	I	-	-	-	-
channel catfish	I	-	-	-	-
KILLIFISHES					
plains killifish	I	75	0.3	3	10.7
LIVEBEARERS					
western mosquitofish	I	38	0.2	9	32.1
SUNFISHES					
green sunfish	I	-	-	-	-
bluegill	I	-	-	-	-
largemouth bass	I	12	*	5	17.9
TOTAL		24,661			

1 N = native; I = introduced
2 Frequency and % frequency of occurrence are based on n=28 samples.

* Value <0.05%

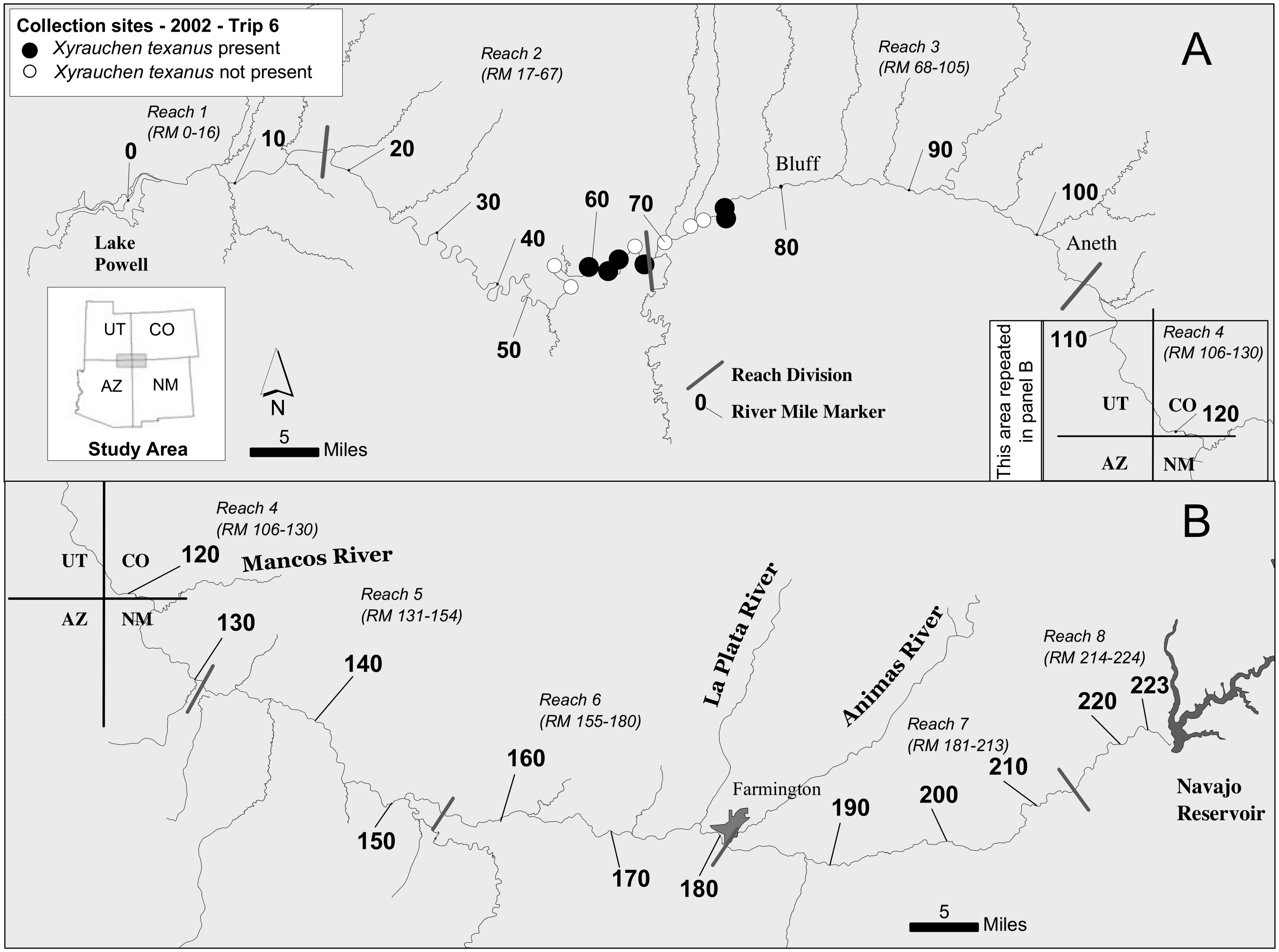


Figure 11. Map of localities sampled during the 6th 2002 San Juan River larval razorback sucker project fish collection (27-29 June 2002; Bluff to Mexican Hat).

Table 11. Summary of the 6th 2002 San Juan River larval razorback sucker project fish collection (27-29 June 2002; Bluff to Mexican Hat).

SPECIES	RESIDENCE STATUS[1]	TOTAL NUMBER OF SPECIMENS	PERCENT OF TOTAL	FREQUENCY OF OCCURRENCE[2]	% FREQUENCY OF OCCURRENCE[2]
CARPS AND MINNOWS					
red shiner	I	6,465	77.1	11	91.7
common carp	I	76	0.9	7	58.3
roundtail chub	N	-	-	-	-
fathead minnow	I	1,566	18.7	12	100.0
Colorado pikeminnow	N	-	-	-	-
speckled dace	N	138	1.7	10	83.3
undetermined Cyprinidae		-	-	-	-
SUCKERS					
flannelmouth sucker	N	29	0.4	8	66.7
bluehead sucker	N	40	0.5	10	83.3
razorback sucker	N	15	0.2	6	50.0
undetermined Catostomidae		-	-	-	-
BULLHEAD CATFISHES					
black bullhead	I	-	-	-	-
channel catfish	I	1	*	1	8.3
KILLIFISHES					
plains killifish	I	-	-	-	-
LIVEBEARERS					
western mosquitofish	I	44	0.5	9	75.0
SUNFISHES					
green sunfish	I	-	-	-	-
bluegill	I	-	-	-	-
largemouth bass	I	7	0.1	3	25.0
TOTAL		8,381			

1 N = native; I = introduced
2 Frequency and % frequency of occurrence are based on n=12 samples.

* Value <0.05%

The second 2002 trip was between Bluff and Clay Hills and occurred from 29 April- 2 May 2002 (Figure 7). The number of fish taken during this sampling effort was only slightly more than that of the first trip. As was recorded during the first 2002 trip, red shiner were, by far, the numerically dominant species (73.7% of the total catch) and was represented exclusively by non-larval individuals. Larval catostomids were much more abundant in the second trip than in the first trip comprising 20.3% of the total catch (Table 7). Flannelmouth sucker (54.8%) and razorback sucker (31.3%) comprised the majority of the catostomid catch.

The third collecting effort of 2002 began at Cudei, New Mexico on 15 May 2002 and terminated on 19 May 2002 at Bluff, Utah (Figure 8). This was the second trip in the upper portion of the study area and the first during 2002 to result in the capture of larval cyprinids. A large portion of the increase in the number of fish collected between trips 1 and 3 was the result of the collection of larval cyprinids. Interestingly, fathead minnow numerically dominated the collection comprising 31% of the total trip 3 catch. Red shiner represented 29.0% of the total trip 3 catch and samples of this species were still primarily comprised of non-larval fish (Table 8). A marked increase in catostomid larvae was documented during the third trip. Catostomids were 36.4% of the total catch with flannelmouth sucker comprising 63.3% and bluehead sucker comprising 33.7% of the total sucker catch.

The next sampling effort, the second lower reach trip and fourth overall effort, was conducted from 29 May - 1 June 2002 (Figure 9). This trip yielded the fewest fish during this study (n=2,068). Flannelmouth sucker was the most numerous taxon taken and comprised 28.2% of the total catch (Table 9). Razorback sucker and speckled dace were about the same proportion (12%) of the total catch. Introduced cyprinids, the majority of which were larval fish, comprised 39.4% of the catch and were equally represented by red shiner and fathead minnow.

The fifth trip was conducted from 10-13 June 2002 and was the last 2002 upper reach sampling effort (Figure 10). This trip produced the largest number of specimens collected during this study (Table 10). Introduced cyprinids constituted 71.2% of the total catch with fathead minnow being 54.2% of the total catch (n=13,373). Catostomids were 21.3% of the trip 5 total catch with flannelmouth sucker and bluehead sucker 65.7% and 32.3%, respectively, of the catostomid catch. Catostomids collected during this trip represented a broad range of developmental stages with some specimens having achieved juvenile stage.

The sixth and final 2002 sampling trip occurred from 27-29 June 2002. The sampling effort was to have been from Bluff, Utah to Clay Hills, Utah but due to extremely low water levels in the San Juan River, the trip was prematurely terminated at Mexican Hat (Figure 11). Introduced cyprinids numerically dominated the collection comprising 95.8% of the total catch. It was noteworthy was that catostomids were only 1% of the total catch (Table 11). The low catch of catostomids was not due to an absence of low velocity or nursery habitats. Instead the reduced number of catostomids in the final 2002 samples suggests an ontogenetic habitat shift by members of this taxonomic group.

Razorback sucker 2002

A total of 812 YOY razorback sucker was taken during the 2002 portion of this study with 44% (n=67) of the samples yielding razorback sucker (Figure 12). It was notable that 20 samples contained >10 YOY razorback sucker while five contained >50 individuals. The largest single collection of razorback sucker (n=91) was in Reach 2 at RM 21.2 on 1 May 2002. The first 2002 larval razorback sucker was collected on 29 April at RM 76.1 (n=2) during the first lower reach sampling effort.

In 2002, razorback sucker exhibited a more uniform longitudinal distribution in the San Juan River compared to previous years. The most upstream YOY razorback sucker collection was RM 134.5 (Reach 5) while the most downstream site of collection was Clay Hills, Utah (RM 2.8). The largest number of sample sites to yield larval razorback sucker was in Reach 3. The 27 Reach 3 samples produced 312 individuals or 38.4% of the 2002 YOY razorback sucker catch. Conversely, Reach 4 yielded the majority (n=320, 39.4%) of the 2002 YOY razorback sucker catch in only 21 samples. Reach

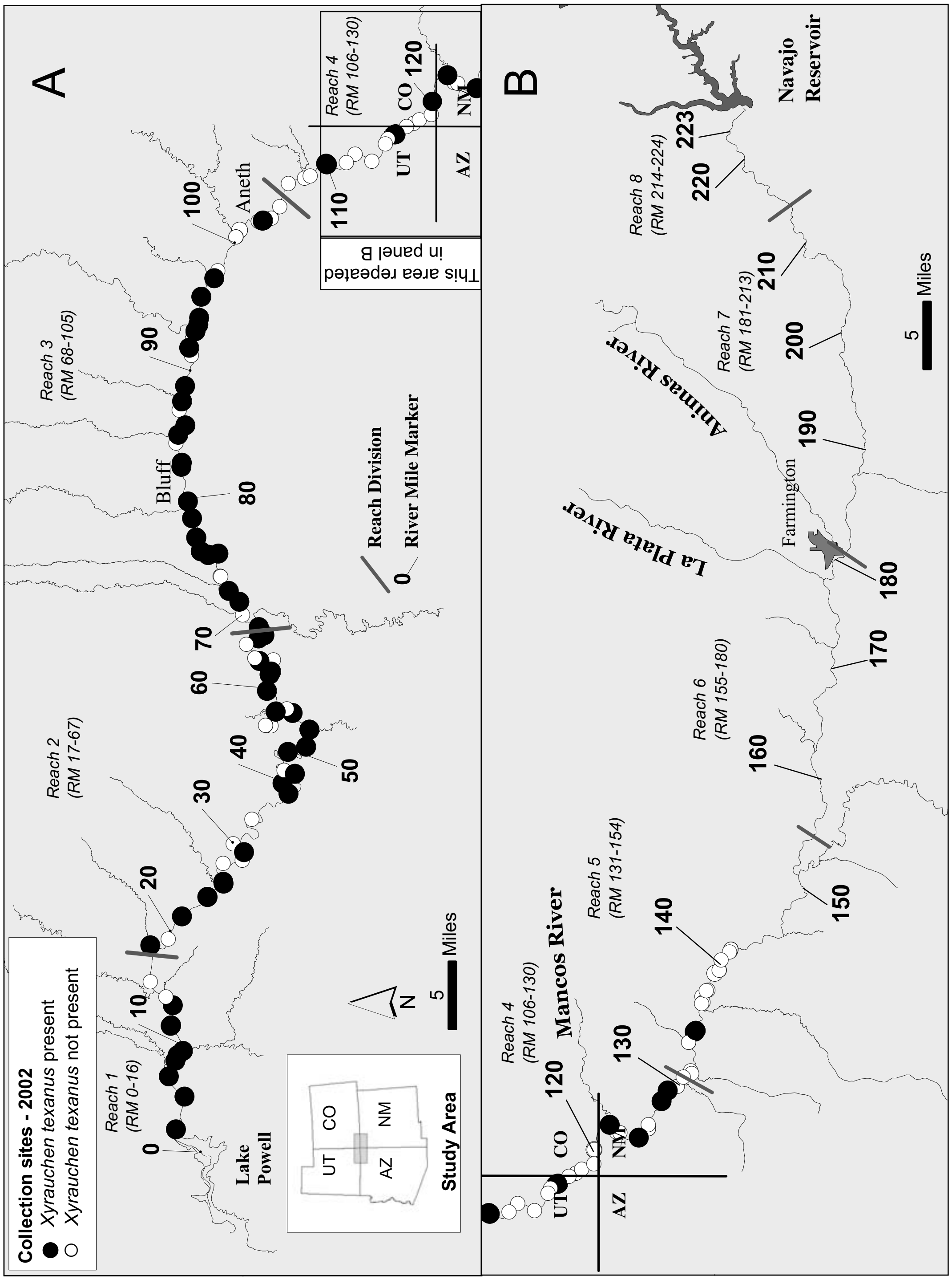


Figure 12. Map of all localities sampled and those that yielded larval and juvenile razorback sucker during 2002.

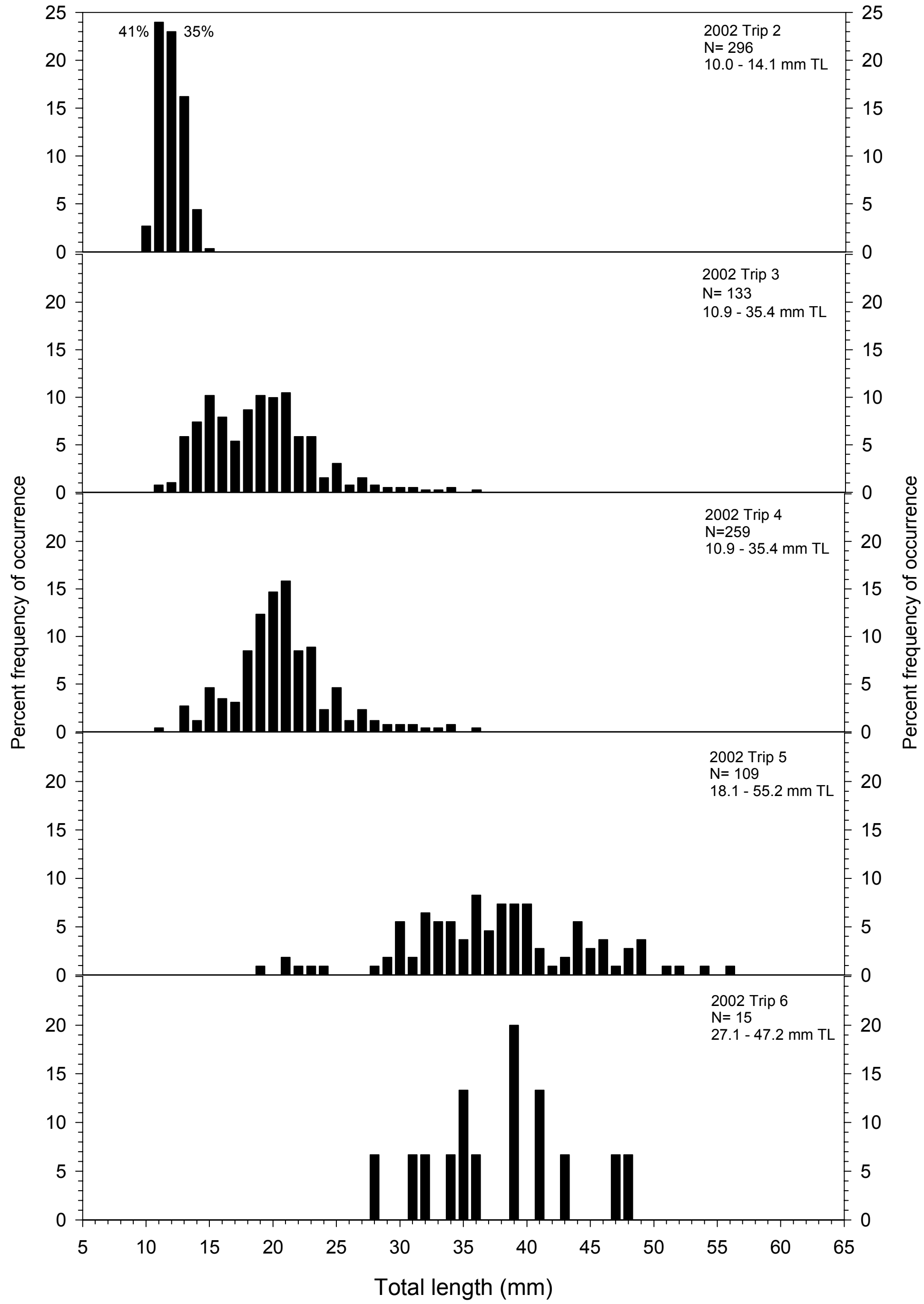


Figure 13. Length frequency histograms for razorback sucker collected from the San Juan River in 2002, by trip.

1, although only sampled twice due to low flow conditions in the river, produced 154 larval razorbacks in nine separate collections and accounted for 19.0% of the total catch of razorback sucker.

The 2002 larval razorback sucker collections yielded more and larger juvenile razorback sucker than have been previously taken. Prior to 2002, there had been only xxx juvenile razorback sucker collected under this study with the largest specimen a 28.8 mm TL individual taken on 14 June 2001. In 2002, 15.9% of YOY razorback sucker collected during this study had reached the juvenile developmental stage with the largest being a 62.4 mm TL individual taken on 28 June 2002. Much like the overall distribution of larval razorback sucker, juvenile razorback sucker were taken in each of the reaches sampled (1- 5).

Summary

A large portion of the approximately 1,000 razorback sucker introduced to the San Juan River since the 1994 initiation of the experimental stocking effort are believed to have survived. If this assumption is true, than the number of stocked razorback sucker that recruit to the adult cohort (i.e., able to reproduce) should continue to increase annually. It follows that as this segment of the population increases, so should the number and spatial distribution of collections of larval razorback sucker.

The 1998 sampling protocol resulted in the collection of over 13,000 specimens, the majority of which were larval catostomids. This 43-fold increase in number of specimens taken, compared to 1997, provided the opportunity to determine, with a higher degree of confidence (than in 1997) if razorback sucker reproduction occurred in the San Juan River during the study period. The high number of larval fish collected in combination with the large reach of river sampled also resulted in substantially better resolution of spawning periodicity of all San Juan River catostomids. The 1998-1999 results of the larval razorback sucker study provided unequivocal documentation of reproduction in the San Juan River by members of a razorback sucker cohort that had been stocked as part of the San Juan River Basin Recovery Implementation Program.

The initial collection of larval razorback sucker in 1998 (n=2) occurred during a single sampling effort and (19 - 22 May) with the specimens being taken and in relatively close proximity to each other (ca. 8 river miles). The effort (1998 sampling) demonstrated that targeting sampling to collect relatively large numbers of larval sucker was an effective means at acquiring information on razorback sucker reproductive efforts. Unlike the 1997 light-trap sampling project, this effort yielded a sufficient number of larval sucker so that biologically meaningful interpretation of the data could be developed.

There were two important discoveries that resulted from the 1999 larval razorback sucker study. The first was the collection of razorback sucker larvae (n=3) from the lower portion of the San Juan River (between RM 10 - 20). As this reach of river was not sampled for larval razorback sucker in 1998, no conclusions could be made regarding expansion of the range of this species by this ontogenetic stage. The second noteworthy 1999 finding was the first collection of larval razorback sucker in light-traps. This sampling technique (light-trapping) has been successfully employed in the Upper Colorado River Basin as a mechanism by which larval razorback sucker can be monitored. The aforementioned San Juan River collection suggests that this passive collecting technique may, one day, be suitable for monitoring of the San Juan River population of razorback sucker.

The 2000 project catch produced more than 14 times the number of larval razorback sucker than had been taken in 1998 and 1999 collectively. The 129 larval razorback sucker collected in 2000 were taken in 21 separate collections from 9 May 2000 to 2 June 2000. Larval razorback sucker were collected at sites from RM 124.8 to RM 8.1. The 2000 collections also documented an upstream extension in the range of larval razorback sucker of 28.6 river miles and a 3.4 river mile downstream range extension. About two-thirds of the 2000 catch of larval razorback sucker was from a single collection made on 26 May 2000 at RM 8.1. The number of larval razorback sucker taken in that sample (n=86) was greater than the cumulative total of all razorback sucker larvae that had been taken preior to 2002 (n=50).

The 2001 collections provided continued documentation of reproduction by razorback sucker. Although their numbers had decreased from the 2000 collections, it is likely that the reduced number of larval razorback sucker taken in 2001 was within the normal boundaries of sample variation that would be experienced in annual fish collections of such a magnitude.

The most apparent and notable result of the 2002 study was the collection of over four times as many YOY razorback sucker than had been taken collectively (1998-2001) during the tenure of this study. There were several other extremely important findings in 2002 besides the large number of individuals taken. The 2002 study documented an increase in both the longitudinal distribution and abundance of naturally spawned razorback sucker and provided preliminary data on growth and habitat association of YOY razorback sucker. Likewise, the 2002 collection of numerous late metalarval and juvenile razorback sucker suggested an ontogenetic shift in habitat association and may yield insights to important distribution patterns of early life-history stages of this species. If the level of reproduction by razorback sucker continues to increase, the validity of the hypotheses will be able to be investigated during subsequent years.

This study continues to provide unequivocal documentation of reproduction in the San Juan River by members of a razorback sucker cohort that had been stocked as part of the San Juan River Recovery Implementation Program. There has been a relatively steady increase in the number of larval razorback sucker taken in the San Juan River. The large number of larval razorback sucker collected in 2002 (n=812) provides credible evidence indicative of continuing reproductive success of the augmented adult population. The increased number of 2002 larval razorback sucker specimens is likely indicative of both an increase in the number of augmented razorback sucker recruited to the spawning cohort and greater reproductive success among previously spawning adults.

As the number of stocked razorback sucker that recruit to the adult cohort (i.e., able to reproduce) continues to increase, so should the number and spatial distribution of collections of larval razorback sucker. Future studies of larval razorback sucker distribution and abundance will provide extremely important information on the level of reproduction of this species and direction necessary to achieve recovery.

Acknowledgments

Numerous individuals assisted with the efforts necessary to accomplish this project. John P. Larson and Lee E. Renfro (MSB) participated in field portions of this study. This project benefited from the invaluable assistance of Ernie Teller and Paul Thompson (Bureau of Indian Affairs). Assistance with all aspects of collection and database management and curation was provided by Alexandra M. Snyder (MSB). Robert K. Dudley (MSB) and Steven P. Platania (MSB) reviewed and commented on this report. This study was approved by the San Juan River Basin Biology Committee through the San Juan River Basin Recovery Implementation Program and funded under a U. S. Bureau of Reclamation, Salt Lake City Project Office, contract administered by Thomas P. Chart (U.S. Bureau of Reclamation). The collecting of fish was authorized under scientific collecting permits provided by the Utah Division of Wildlife Resources, New Mexico Department of Game and Fish, U.S. Fish and Wildlife Service, and Navajo Nation. Finally, we thank Darrel E. Snyder, Larval Fish Laboratory, Colorado State University, for verification of specimen identification.

Literature Cited

Bliesner, R. and V. Lamarra. 1999. Chapter 2. Geomorphology, hydrology, and habitat of the San Juan River. Pages 2-1 to 2-30 *In*: P. B. Holden, editor. Flow recommendations for the San Juan River. San Juan River Basin Recovery Implementation Program, USFWS, Albuquerque, New Mexico.

Jordan, D. S. 1891. Reports of explorations in Colorado and Utah during the summer of 1889, with an account of the fish found in each of the river basins examined. Bulletin of the U.S. Fish Commission 89:1-40.

Roberts, B. and M. Moretti. 1989. Fisheries survey of the San Juan River, Utah 1998. Report to the Utah Division of Wildlife Resources, (Cooperative Argeement 7-FC-40-05050), Salt Lake City, Utah. 40 pp.

Robins, R. R., R. M. Bailey, C. E. Bond, J. R. Brooker, E. A. Lachner, R. N. Lea, and W. B. Scott.1991. Common and scientific names of fishes from the United States and Canada. Special Publication of the American Fisheries Society 20:1 - 183.

Ryden, D. W. and F. K. Pfeifer. 1996 . Adult fish community monitoring on the San Juan River: 1995 Annual Progress Report. U.S. Fish and Wildlife Service, Grand Junction, Colorado. 46 pp.

Snyder, D. E. 1981. Contributions to a guide to the cypriniform fish larvae of the Upper Colorado River system in Colorado. U.S. Bureau of Land Management, Biological Sciences Series 3, Denver, CO. 81 pp.

VTN Consolidated, Inc., and Museum of Northern Arizona. 1978. Fish, wildlife, and habitat assessment; San Juan River, New Mexico and Utah. Gallup-Navajo Indian water supply project.VTN Consolidated, Inc., Irvine, California. 241 pp.

U.S. Bureau of Reclamation. 1987. San Juan River rare and endangered fish study: river miles 16.2- (-) 2.0; 1987 field season. U.S. Bureau of Reclamation, Durango Projects Office, Durango, Colorado. 24 pp.

Appendix I. Summary of larval razorback sucker collected in the San Juan River.

Field Number	MSB Catalog Number	Number of Specimens	Total Length	Larval Stage	Date Collected	River Mile	Sampling Method
1998	**TOTAL**	**2**					
WHB98-143	42207	1	12.7	mesolarva	21 May 1998	88.8	larval fish seine
WHB98-147	42218	1	12.1	mesolarva	22 May 1998	80.2	larval fish seine
1999	**TOTAL**	**7**					
WHB99-075	44201	1	11.2	mesolarva/yolk	04 May 1999	82.5	larval fish seine
WHB99-105	44254	1	14.1	mesolarva	12-13 May 1999	96.2	light-trap
WHB99-106	44257	1	10.2	mesolarva	12-13 May 1999	96.2	light-trap
WHB99-112	44269	1	11.2	protolarva/yolk	13 May 1999	82.5	larval fish seine
WHB99-167	44421	1	17.9	mesolarva	14 June 1999	16.5	larval fish seine
WHB99-169	44428	1	20.7	metalarva	14 June 1999	13.1	larval fish seine
WHB99-170	44435	1	13.8	mesolarva	14 June 1999	11.5	larval fish seine
2000	**TOTAL**	**129**					
WHB00-104	47770	1	10.4	mesolarva	09 May 2000	104.6	larval fish seine
WHB00-108	47779	2	10.6 - 11.3	mesolarvae	10 May 2000	99.7	larval fish seine
WHB00-109	47784	1	10.9	mesolarva	10 May 2000	99.4	larval fish seine
WHB00-115	47805	5	10.4 - 11.3	mesolarvae/yolk	10 May 2000	89.2	larval fish seine
WHB00-116	47808	1	11.1	mesolarva	10 May 2000	88.8	larval fish seine
WHB00-118	47814	3	10.5 - 10.8	mesolarvae	11 May 2000	85.6	larval fish seine
WHB00-119	47819	5	10.6 - 11.8	mesolarvae	11 May 2000	84.1	larval fish seine
WHB00-121	47824	1	10.6	mesolarva	11 May 2000	82.3	larval fish seine
WHB00-122	47829	6	10.4 - 13.2	mesolarvae	11 May 2000	79.4	larval fish seine
WHB00-130	47855	1	15.2	mesolarva	23 May 2000	69.5	larval fish seine
WHB00-133	47864	1	10.0	mesolarva	23 May 2000	59.8	larval fish seine
WHB00-139	47878	1	14.9	mesolarva	24 May 2000	40.5	larval fish seine
WHB00-143	47882	2	9.3 - 18.6	mesolarvae	25 May 2000	23.3	larval fish seine
WHB00-149	47896	1	16.1	mesolarva	26 May 2000	15.4	larval fish seine
WHB00-150	47902	1	17.6	mesolarva	26 May 2000	14.0	larval fish seine
WHB00-152	47910	6	15.3 - 17.9	mesolarvae	26 May 2000	13.0	larval fish seine
WHB00-154	47918	1	12.2	mesolarva	26 May 2000	10.0	larval fish seine
WHB00-155	47924	2	13.6 - 16.4	mesolarvae	26 May 2000	8.8	larval fish seine
WHB00-156	47930	86	9.4 - 18.1	meso - metalarvae	26 May 2000	8.1	larval fish seine
WHB00-158	47937	1	16.4	mesolarva	01 June 2000	124.8	larval fish seine
WHB00-168	47978	1	12.0	mesolarva	02 June 2000	104.5	larval fish seine
2001	**TOTAL**	**50**					
WHB01-123	48806	2	15.5 - 16.0	mesolarvae	16 May 2001	62.1	larval fish seine
WHB01-133	48832	1	13.8	mesolarva	17 May 2001	21.1	light-trap
WHB01-134	48834	1	13.5	mesolarva	17 May 2001	21.0	light-trap
WHB01-137	48843	1	11.3	mesolarva	18 May 2001	16.5	larval fish seine
WHB01-138	48846	1	15.5	mesolarva	18 May 2001	16.4	larval fish seine
WHB01-145	48873	11	10.1 - 14.8	mesolarvae	18 May 2001	9.5	larval fish seine
WHB01-146	48879	4	11.7 - 14.8	mesolarvae	18 May 2001	8.5	larval fish seine
WHB01-157	48918	1	14.3	mesolarva	30 May 2001	124.8	larval fish seine
WHB01-172	48978	1	17.5	metalarva	31 May 2001	89.2	larval fish seine
WHB01-173	48984	1	13.0	mesolarva	31 May 2001	88.8	larval fish seine
WHB01-175	48992	1	19.4	metalarva	1 June 2001	80.2	larval fish seine
WHB01-200	49078	4	22.0 - 26.3	metalarvae	14 June 2001	13.0	larval fish seine
WHB01-201	49082	1	17.2	metalarva	14 June 2001	11.9	larval fish seine
WHB01-203	49096	4	16.0 - 18.5	meso - metalarvae	14 June 2001	10.0	larval fish seine
WHB01-205	49108	16	16.1 - 28.8	metalarvae/juvenile	14 June 2001	8.1	larval fish seine
TOTAL (1998-2001)		**188**					

Appendix I. Summary of larval razorback sucker collected in the San Juan River (continued).

Field Number	Number of Specimens	Total Length	Larval Stage	Date Collected	River Mile	Sampling Method
2002 TOTAL	**812**					
WHB02-028	2	10.2- 11.0	protolarvae	29 April 2002	76.1	larval fish seine
WHB02-029	1	10.8	protolarva	29 April 2002	75.5	larval fish seine
WHB02-032	1	10.8	protolarva	29 April 2002	68.3	larval fish seine
WHB02-033	18	10.2- 11.5	proto - mesolarvae/yolk	29 April 2002	66.8	larval fish seine
WHB02-037	2	11.0- 11.1	mesolarvae	30 April 2002	58.2	larval fish seine
WHB02-039	1	10.5	mesolarva	30 April 2002	54.5	larval fish seine
WHB02-040	6	10.5- 12.8	proto - mesolarvae	30 April 2002	52.3	larval fish seine
WHB02-043	27	9.7- 12.3	proto - mesolarvae/yolk	1 May 2002	43.0	larval fish seine
WHB02-046	1	12.9	mesolarva	1 May 2002	25.0	larval fish seine
WHB02-047	12	10.9- 11.9	proto - mesolarvae	1 May 2002	23.5	larval fish seine
WHB02-048	91	10.0- 13.8	proto - mesolarvae/yolk	1 May 2002	21.2	larval fish seine
WHB02-051	1	10.7	mesolarva	2 May 2002	12.9	larval fish seine
WHB02-052	18	10.7- 13.3	mesolarvae	2 May 2002	11.6	larval fish seine
WHB02-053	2	11.3- 13.2	mesolarvae	2 May 2002	9.2	larval fish seine
WHB02-054	89	10.1- 13.9	mesolarvae	2 May 2002	8.7	larval fish seine
WHB02-055	24	10.1- 14.1	mesolarvae	2 May 2002	5.2	larval fish seine
WHB02-064	2	12.1- 13.7	mesolarvae	16 May 2002	129.1	larval fish seine
WHB02-066	3	12.4- 13.9	mesolarvae	16 May 2002	124.8	larval fish seine
WHB02-067	7	12.5- 15.5	mesolarvae	16 May 2002	122.6	larval fish seine
WHB02-070	5	11.0- 12.6	mesolarvae	16 May 2002	116.2	light-trap
WHB02-073	3	13.0- 13.6	mesolarvae	17 May 2002	110.1	larval fish seine
WHB02-078	5	13.5- 14.6	mesolarvae	17 May 2002	97.1	light-trap
WHB02-079	39	12.8- 18.3	meso - metalarvae	18 May 2002	95.8	larval fish seine
WHB02-080	1	18.7	metalarva	18 May 2002	93.7	larval fish seine
WHB02-081	36	12.6- 19.8	meso - metalarvae	18 May 2002	93.0	larval fish seine
WHB02-082	1	15.3	mesolarva	18 May 2002	88.8	larval fish seine
WHB02-083	2	13.4- 17.6	meso - metalarvae	18 May 2002	87.8	larval fish seine
WHB02-084	1	11.0	mesolarva	18 May 2002	85.8	larval fish seine
WHB02-085	3	13.4- 18.8	meso - metalarvae	18 May 2002	82.8	larval fish seine
WHB02-086	21	11.5- 18.8	meso - metalarvae	18 May 2002	78.9	light-trap
WHB02-087	4	11.9- 21.5	meso - metalarvae	19 May 2002	77.2	larval fish seine
WHB02-088	14	15.5- 26.4	meso - metalarvae	29 May 2002	75.7	larval fish seine
WHB02-090	4	17.8- 30.7	metalarvae - juvenile	29 May 2002	71.9	larval fish seine
WHB02-091	51	14.9- 26.8	meso - metalarvae	29 May 2002	71.3	larval fish seine
WHB02-093	19	16.8- 29.7	mesolarvae - juvenile	29 May 2002	60.6	larval fish seine
WHB02-094	1	20.3	metalarva	30 May 2002	58.2	larval fish seine
WHB02-096	71	12.4- 26.6	meso - metalarvae	30 May 2002	52.5	larval fish seine
WHB02-097	4	14.8- 24.3	meso - metalarvae	30 May 2002	50.7	larval fish seine
WHB02-098	1	20.6	metalarva	30 May 2002	48.0	larval fish seine
WHB02-100	11	10.9- 26.5	meso - metalarvae	30 May 2002	41.7	larval fish seine
WHB02-101	2	20.1- 26.7	metalarvae	31 May 2002	38.9	larval fish seine
WHB02-104	2	18.6- 21.0	metalarvae	31 May 2002	29.0	larval fish seine
WHB02-105	7	17.4- 29.7	meso - metalarvae	31 May 2002	25.2	larval fish seine
WHB02-106	50	14.5- 33.4	mesolarvae - juvenile	31 May 2002	23.4	larval fish seine
WHB02-107	1	33.3	juvenile	31 May 2002	17.6	larval fish seine
WHB02-109	1	14.6	mesolarva	1 June 2002	11.5	larval fish seine
WHB02-110	3	20.8- 25.3	metalarvae	1 June 2002	9.6	larval fish seine
WHB02-111	13	12.6- 35.4	mesolarvae - juvenile	1 June 2002	7.3	larval fish seine
WHB02-112	4	14.7- 24.3	meso - metalarvae	1 June 2002	2.8	larval fish seine
WHB02-118	1	35.8	juvenile	11 June 2002	134.5	larval fish seine
WHB02-121	1	33.1	juvenile	11 June 2002	128.1	larval fish seine
WHB02-126	2	29.4- 35.3	metalarvae - juvenile	12 June 2002	116.2	larval fish seine
WHB02-128	1	30.9	juvenile	12 June 2002	109.8	larval fish seine
WHB02-130	2	37.2- 49.0	juvenile	12 June 2002	103.2	larval fish seine
WHB02-133	3	32.4- 43.4	juvenile	13 June 2002	94.0	larval fish seine
WHB02-134	23	29.7- 55.2	metalarvae - juvenile	13 June 2002	93.0	larval fish seine

Appendix I. Summary of larval razorback sucker collected in the San Juan River (continued).

Field Number	Number of Specimens	Total Length	Larval Stage	Date Collected	River Mile	Sampling Method
2002 (cont.)						
WHB02-135	48	20.4- 50.8	metalarvae - juvenile	13 June 2002	91.6	larval fish seine
WHB02-137	2	37.0- 38.1	juvenile	13 June 2002	84.6	larval fish seine
WHB02-138	14	31.7- 40.3	juvenile	13 June 2002	82.6	larval fish seine
WHB02-139	4	33.9- 52.0	juvenile	13 June 2002	79.7	larval fish seine
WHB02-140	8	18.1- 46.7	mesolarvae - juvenile	13 June 2002	77.1	larval fish seine
WHB02-141	1	53.1	juvenile	27 June 2002	75.4	larval fish seine
WHB02-142	2	35.6- 49.3	juvenile	27 June 2002	74.9	larval fish seine
WHB02-146	1	51.1	juvenile	28 June 2002	68.7	larval fish seine
WHB02-148	2	59.5- 62.4	juvenile	28 June 2002	62.3	larval fish seine
WHB02-149	8	41.8- 54.4	juvenile	28 June 2002	61.3	larval fish seine
WHB02-150	1	39.8	juvenile	28 June 2002	60.2	larval fish seine

TOTAL (1998 - 2002) 1,000

Appendix II. Detailed summary of larval razorback sucker collected in the San Juan River.

Field Number	MSB Catalog Number	Number of Specimens	Total Length	Larval Stage	Date Collected	River Mile	Sampling Method
1998	**TOTAL**	**2**					
WHB98-143	42207	1	12.7	mesolarva	21 May 1998	88.8	larval fish seine
WHB98-147	42218	1	12.1	mesolarva	22 May 1998	80.2	larval fish seine
1999	**TOTAL**	**7**					
WHB99-075	44201	1	11.2	mesolarva/yolk	04 May 1999	82.5	larval fish seine
WHB99-105	44254	1	14.1	mesolarva	12-13 May 1999	96.2	light-trap
WHB99-106	44257	1	10.2	mesolarva	12-13 May 1999	96.2	light-trap
WHB99-112	44269	1	11.2	protolarva/yolk	13 May 1999	82.5	larval fish seine
WHB99-167	44421	1	17.9	mesolarva	14 June 1999	16.5	larval fish seine
WHB99-169	44428	1	20.7	metalarva	14 June 1999	13.1	larval fish seine
WHB99-170	44435	1	13.8	mesolarva	14 June 1999	11.5	larval fish seine
2000	**TOTAL**	**129**					
WHB00-104	47770	1	10.4	mesolarva	09 May 2000	104.6	larval fish seine
WHB00-108	47779	2	10.6	mesolarva	10 May 2000	99.7	larval fish seine
			11.3	mesolarva	10 May 2000	99.7	larval fish seine
WHB00-109	47784	1	10.9	mesolarva	10 May 2000	99.4	larval fish seine
WHB00-115	47805	5	10.4	mesolarva/yolk	10 May 2000	89.2	larval fish seine
			10.0	mesolarva	10 May 2000	89.2	larval fish seine
			10.2	mesolarva	10 May 2000	89.2	larval fish seine
			10.3	mesolarva	10 May 2000	89.2	larval fish seine
			11.3	mesolarva	10 May 2000	89.2	larval fish seine
WHB00-116	47808	1	11.1	mesolarva	10 May 2000	88.8	larval fish seine
WHB00-118	47814	3	10.5	mesolarva	11 May 2000	85.6	larval fish seine
			10.8	mesolarva	11 May 2000	85.6	larval fish seine
			10.8	mesolarva	11 May 2000	85.6	larval fish seine
WHB00-119	47819	5	10.6	mesolarva	11 May 2000	84.1	larval fish seine
			10.8	mesolarva	11 May 2000	84.1	larval fish seine
			10.9	mesolarva	11 May 2000	84.1	larval fish seine
			11.1	mesolarva	11 May 2000	84.1	larval fish seine
			11.8	mesolarva	11 May 2000	84.1	larval fish seine
WHB00-121	47824	1	10.6	mesolarva	11 May 2000	82.3	larval fish seine
WHB00-122	47829	6	10.4	mesolarva	11 May 2000	79.4	larval fish seine
			10.7	mesolarva	11 May 2000	79.4	larval fish seine
			11.2	mesolarva	11 May 2000	79.4	larval fish seine
			11.2	mesolarva	11 May 2000	79.4	larval fish seine
			11.6	mesolarva	11 May 2000	79.4	larval fish seine
			13.2	mesolarva	11 May 2000	79.4	larval fish seine
WHB00-130	47855	1	15.2	mesolarva	23 May 2000	69.5	larval fish seine
WHB00-133	47864	1	10.0	mesolarva	23 May 2000	59.8	larval fish seine
WHB00-139	47878	1	14.9	mesolarva	24 May 2000	40.5	larval fish seine
WHB00-143	47882	2	9.3	mesolarva	25 May 2000	23.3	larval fish seine
			18.6	mesolarva	25 May 2000	23.3	larval fish seine
WHB00-149	47896	1	16.1	mesolarva	26 May 2000	15.4	larval fish seine
WHB00-150	47902	1	17.6	mesolarva	26 May 2000	14.0	larval fish seine
WHB00-152	47910	6	15.3	mesolarva	26 May 2000	13.0	larval fish seine
			15.8	mesolarva	26 May 2000	13.0	larval fish seine
			16.1	mesolarva	26 May 2000	13.0	larval fish seine
			17.0	mesolarva	26 May 2000	13.0	larval fish seine
			17.3	mesolarva	26 May 2000	13.0	larval fish seine
			17.9	mesolarva	26 May 2000	13.0	larval fish seine

Appendix II. Detailed summary of larval razorback sucker collected in the San Juan River (continued).

Field Number	MSB Catalog Number	Number of Specimens	Total Length	Larval Stage	Date Collected	River Mile	Sampling Method
WHB00-154	47918	1	12.2	mesolarva	26 May 2000	10.0	larval fish seine
WHB00-155	47924	2	13.6	mesolarva	26 May 2000	8.8	larval fish seine
			16.4	mesolarva	26 May 2000	8.8	larval fish seine
WHB00-156	47930	86			26 May 2000	8.1	larval fish seine
		(6)	9.4-10.1	mesolarvae/yolk	26 May 2000	8.1	larval fish seine
		(6)	10.0-11.7	mesolarvae	26 May 2000	8.1	larval fish seine
		(58)	11.8-15.4	mesolarvae	26 May 2000	8.1	larval fish seine
		(15)	15.5-17.4	mesolarvae	26 May 2000	8.1	larval fish seine
		(1)	18.1	metalarva	26 May 2000	8.1	larval fish seine
WHB00-158	47937	1	16.4	mesolarva	01 June 2000	124.8	larval fish seine
WHB00-168	47978	1	12.0	mesolarva	02 June 2000	104.5	larval fish seine
2001	**TOTAL**	**50**					
WHB01-123	48806	2	15.5-16.0	postflexion mesolarvae	16 May 2001	62.1	larval fish seine
WHB01-133	48832	1	13.8	postflexion mesolarva	17-18 May 2001	21.1	light-trap
WHB01-134	48834	1	13.5	postflexion mesolarva	17-18 May 2001	21.1	light-trap
WHB01-137	48843	1	11.3	flexion mesolarva	18 May 2001	16.5	larval fish seine
WHB01-138	48846	1	15.5	postflexion mesolarva	18 May 2001	16.4	larval fish seine
WHB01-145	48873	11			18 May 2001	9.5	larval fish seine
		(2)	10.1-10.2	preflexion mesolarvae	18 May 2001	9.5	larval fish seine
		(5)	10.8-13.0	flexion mesolarvae	18 May 2001	9.5	larval fish seine
		(4)	14.0-14.8	postflexion mesolarvae	18 May 2001	9.5	larval fish seine
WHB01-146	48879	4			18 May 2001	8.5	larval fish seine
		(1)	11.7	flexion mesolarva	18 May 2001	8.5	larval fish seine
		(3)	13.9-14.8	postflexion mesolarvae	18 May 2001	8.5	larval fish seine
WHB01-157	48918	1	14.3	postflexion mesolarva	30 May 2001	124.8	larval fish seine
WHB01-172	48978	1	17.5	metalarva	31 May 2001	89.2	larval fish seine
WHB01-173	48984	1	13	flexion mesolarva	31 May 2001	88.8	larval fish seine
WHB01-175	48992	1	19.4	metalarva	1 June 2001	80.2	larval fish seine
WHB01-200	49078	4	22.0-26.3	metalarvae	14 June 2001	13.0	larval fish seine
WHB01-201	49082	1	17.2	metalarva	14 June 2001	11.9	larval fish seine
WHB01-203	49096	4			14 June 2001	10.0	larval fish seine
		(2)	16.0-16.4	postflexion mesolarvae	14 June 2001	10.0	larval fish seine
		(2)	16.8-18.5	metalarvae	14 June 2001	10.0	larval fish seine
WHB01-205	49108	16			14 June 2001	8.1	larval fish seine
		(1)	16.1	postflexion mesolarva	14 June 2001	8.1	larval fish seine
		(13)	17.7-25.8	metalarvae	14 June 2001	8.1	larval fish seine
		(2)	26.8-28.8	juvenile	14 June 2001	8.1	larval fish seine
TOTAL (1998 - 2001)		**188**					

Appendix II. Detailed summary of larval razorback sucker collected in the San Juan River (continued).

Field Number	Number of Specimens	Total Length	Larval Stage	Date Collected	River Mile	Sampling Method
2002 TOTAL	**812**					
WHB02-028	2	10.2 -11.0	protolarvae	29 April 2002	76.1	larval fish seine
WHB02-029	1	10.8	protolarva	29 April 2002	75.5	larval fish seine
WHB02-032	1	10.8	protolarva	29 April 2002	68.3	larval fish seine
WHB02-033	18			29 April 2002	66.8	larval fish seine
	(11)	10.1 -11.1	protolarvae	29 April 2002	66.8	larval fish seine
	(6)	10.5 -11.2	preflexion mesolarvae	29 April 2002	66.8	larval fish seine
	(1)	11.5	flexion mesolarvae	29 April 2002	66.8	larval fish seine
WHB02-037	2	11.0 -11.1	preflexion mesolarvae	30 April 2002	58.2	larval fish seine
WHB02-039	1	10.5	preflexion mesolarva	30 April 2002	54.5	larval fish seine
WHB02-040	5			30 April 2002	52.3	larval fish seine
	(1)	10.5	protolarvae	30 April 2002	52.3	larval fish seine
	(2)	10.8 -10.8	preflexion mesolarvae	30 April 2002	52.3	larval fish seine
	(3)	12.1 -12.8	flexion mesolarvae	30 April 2002	52.3	larval fish seine
WHB02-043	27			1 May 2002	43.0	larval fish seine
	(10)	9.7 -10.3	protolarvae	1 May 2002	43.0	larval fish seine
	(12)	10.1 -11.0	preflexion mesolarvae	1 May 2002	43.0	larval fish seine
	(1)	10.3	postflexion mesolarvae	1 May 2002	43.0	larval fish seine
	(4)	10.7 -12.3	flexion mesolarvae	1 May 2002	43.0	larval fish seine
WHB02-046	1	12.9	flexion mesolarva	1 May 2002	25.0	larval fish seine
WHB02-047	12			1 May 2002	23.5	larval fish seine
	(7)	10.9 -11.5	preflexion mesolarvae	1 May 2002	23.5	larval fish seine
	(2)	10.9 -11.1	protolarvae	1 May 2002	23.5	larval fish seine
	(3)	11.8 -11.9	flexion mesolarvae	1 May 2002	23.5	larval fish seine
WHB02-048	91			1 May 2002	21.2	larval fish seine
	(23)	10.0 -11.5	protolarvae	1 May 2002	21.2	larval fish seine
	(34)	10.2 -12.0	preflexion mesolarvae	1 May 2002	21.2	larval fish seine
	(32)	10.6 -13.4	flexion mesolarvae	1 May 2002	21.2	larval fish seine
	(2)	12.7 -13.8	postflexion mesolarvae	1 May 2002	21.2	larval fish seine
WHB02-051	1	10.7	preflexion mesolarva	2 May 2002	12.9	larval fish seine
WHB02-052	18			2 May 2002	11.6	larval fish seine
	(15)	10.7 -13.3	flexion mesolarvae	2 May 2002	11.6	larval fish seine
	(1)	10.9	preflexion mesolarva	2 May 2002	11.6	larval fish seine
	(2)	12.7 -13.2	postflexion mesolarvae	2 May 2002	11.6	larval fish seine
WHB02-053	2			2 May 2002	9.2	larval fish seine
	(1)	11.3	flexion mesolarva	2 May 2002	9.2	larval fish seine
	(1)	13.2	postflexion mesolarva	2 May 2002	9.2	larval fish seine
WHB02-054	89			2 May 2002	8.7	larval fish seine
	(69)	10.1 -13.1	flexion mesolarvae	2 May 2002	8.7	larval fish seine
	(13)	10.2 -11.2	preflexion mesolarvae	2 May 2002	8.7	larval fish seine
	(7)	12.5 -13.9	postflexion mesolarvae	2 May 2002	8.7	larval fish seine
WHB02-055	24			2 May 2002	5.2	larval fish seine
	(1)	10.1	preflexion mesolarva	2 May 2002	5.2	larval fish seine
	(20)	10.5 -13.0	flexion mesolarvae	2 May 2002	5.2	larval fish seine
	(3)	12.8 -14.1	postflexion mesolarvae	2 May 2002	5.2	larval fish seine
WHB02-064	2			16 May 2002	129.1	larval fish seine
	(1)	12.1	flexion mesolarva	16 May 2002	129.1	larval fish seine
	(1)	13.7	postflexion mesolarva	16 May 2002	129.1	larval fish seine
WHB02-066	3			16 May 2002	124.8	larval fish seine
	(2)	12.4 -13.9	postflexion mesolarvae	16 May 2002	124.8	larval fish seine
	(1)	12.7	flexion mesolarvae	16 May 2002	124.8	larval fish seine
WHB02-067	7			16 May 2002	122.6	larval fish seine
	(6)	12.5 -15.5	postflexion mesolarvae	16 May 2002	122.6	larval fish seine
	(1)	12.6	flexion mesolarva	16 May 2002	122.6	larval fish seine
WHB02-070	5			16-17 May 2002	116.2	light-trap
	(3)	11.0 -12.4	flexion mesolarvae	16-17 May 2002	116.2	light-trap
	(2)	12.0 -12.6	postflexion mesolarvae	16-17 May 2002	116.2	light-trap

Appendix II. Detailed summary of larval razorback sucker collected in the San Juan River (continued).

Field Number	Number of Specimens	Total Length	Larval Stage	Date Collected	River Mile	Sampling Method
WHB02-073	3	13.0 -13.6	postflexion mesolarvae	17 May 2002	110.1	larval fish seine
WHB02-078	5	13.5 -14.6	postflexion mesolarvae	17-18 May 2002	97.1	light-trap
WHB02-079	39			18 May 2002	95.8	larval fish seine
	(4)	12.8 -13.3	flexion mesolarvae	18 May 2002	95.8	larval fish seine
	(32)	13.5 -18.0	postflexion mesolarvae	18 May 2002	95.8	larval fish seine
	(3)	17.6 -18.3	metalarvae	18 May 2002	95.8	larval fish seine
WHB02-080	1	18.7	metalarva	18 May 2002	93.7	larval fish seine
WHB02-081	36			18 May 2002	93.0	larval fish seine
	(1)	12.6	flexion mesolarvae	18 May 2002	93.0	larval fish seine
	(30)	12.8 -18.0	postflexion mesolarvae	18 May 2002	93.0	larval fish seine
	(5)	18.7 -19.8	metalarvae	18 May 2002	93.0	larval fish seine
WHB02-082	1	15.3	postflexion mesolarva	18 May 2002	88.8	larval fish seine
WHB02-083	2			18 May 2002	87.8	larval fish seine
	(1)	13.4	postflexion mesolarva	18 May 2002	87.8	larval fish seine
	(1)	17.6	metalarva	18 May 2002	87.8	larval fish seine
WHB02-084	1	11.0	flexion mesolarva	18 May 2002	85.8	larval fish seine
WHB02-085	3			18 May 2002	82.8	larval fish seine
	(2)	13.4 -14.8	postflexion mesolarvae	18 May 2002	82.8	larval fish seine
	(1)	18.8	metalarva	18 May 2002	82.8	larval fish seine
WHB02-086	21			18-19 May 2002	78.9	light-trap
	(2)	11.5 -12.0	flexion mesolarvae	18-19 May 2002	78.9	light-trap
	(16)	12.6 -17.0	postflexion mesolarvae	18-19 May 2002	78.9	light-trap
	(3)	17.5 -18.8	metalarvae	18-19 May 2002	78.9	light-trap
WHB02-087	4			19 May 2002	77.2	larval fish seine
	(1)	11.9	flexion mesolarva	19 May 2002	77.2	larval fish seine
	(2)	14.8 -14.8	postflexion mesolarvae	19 May 2002	77.2	larval fish seine
	(1)	21.5	metalarva	19 May 2002	77.2	larval fish seine
WHB02-088	14			29 May 2002	75.7	larval fish seine
	(1)	15.5	postflexion mesolarva	29 May 2002	75.7	larval fish seine
	(13)	17.6 -26.4	metalarvae	29 May 2002	75.7	larval fish seine
WHB02-090	4			29 May 2002	71.9	larval fish seine
	(3)	17.8 -24.8	metalarvae	29 May 2002	71.9	larval fish seine
	(1)	30.7	juvenile	29 May 2002	71.9	larval fish seine
WHB02-091	51			29 May 2002	71.3	larval fish seine
	(7)	14.5 -17.8	postflexion mesolarvae	29 May 2002	71.3	larval fish seine
	(44)	15.0 -26.8	metalarvae	29 May 2002	71.3	larval fish seine
WHB02-093	19			29 May 2002	60.6	larval fish seine
	(4)	16.8 -18.1	postflexion mesolarvae	29 May 2002	60.6	larval fish seine
	(13)	18.7 -24.8	metalarvae	29 May 2002	60.6	larval fish seine
	(2)	28.3 -29.7	juvenile	29 May 2002	60.6	larval fish seine
WHB02-094	1	20.3	metalarva	30 May 2002	58.2	larval fish seine
WHB02-096	71			30 May 2002	52.5	larval fish seine
	(6)	12.3 -13.2	flexion mesolarvae	30 May 2002	52.5	larval fish seine
	(14)	14.3 -18.8	postflexion mesolarvae	30 May 2002	52.5	larval fish seine
	(51)	17.9 -26.6	metalarvae	30 May 2002	52.5	larval fish seine
WHB02-097	4			30 May 2002	50.7	larval fish seine
	(2)	14.8 -15.3	postflexion mesolarvae	30 May 2002	50.7	larval fish seine
	(2)	20.2 -24.3	metalarvae	30 May 2002	50.7	larval fish seine
WHB02-098	1	20.6	metalarva	30 May 2002	48.0	larval fish seine
WHB02-100	11			30 May 2002	41.7	larval fish seine
	(1)	10.9	flexion mesolarva	30 May 2002	41.7	larval fish seine
	(3)	13.7 -17.8	postflexion mesolarvae	30 May 2002	41.7	larval fish seine
	(7)	17.3 -26.5	metalarvae	30 May 2002	41.7	larval fish seine
WHB02-101	2	20.1 -26.7	metalarvae	31 May 2002	38.9	larval fish seine
WHB02-104	2	18.6 -21.0	metalarvae	31 May 2002	29.0	larval fish seine
WHB02-105	7			31 May 2002	25.2	larval fish seine
	(1)	17.4	postflexion mesolarva	31 May 2002	25.2	larval fish seine
	(6)	22.9 -29.7	metalarvae	31 May 2002	25.2	larval fish seine

Appendix II. Detailed summary of larval razorback sucker collected in the San Juan River (continued).

Field Number	Number of Specimens	Total Length	Larval Stage	Date Collected	River Mile	Sampling Method
WHB02-106	50			31 May 2002	23.4	larval fish seine
	(1)	12.9	flexion mesolarva	31 May 2002	23.4	larval fish seine
	(9)	14.5 -18.8	postflexion mesolarvae	31 May 2002	23.4	larval fish seine
	(34)	17.7 -27.2	metalarvae	31 May 2002	23.4	larval fish seine
	(6)	28.0 -33.4	juvenile	31 May 2002	23.4	larval fish seine
WHB02-107	1	33.3	juvenile	31 May 2002	17.6	larval fish seine
WHB02-109	1	14.6	postflexion mesolarvae	1 June 2002	11.5	larval fish seine
WHB02-110	3	20.8 -25.3	metalarvae	1 June 2002	9.6	larval fish seine
WHB02-111	13			1 June 2002	7.3	larval fish seine
	(8)	12.6 -16.7	postflexion mesolarvae	1 June 2002	7.3	larval fish seine
	(4)	17.1 -22.8	metalarvae	1 June 2002	7.3	larval fish seine
	(1)	35.4	juvenile	1 June 2002	7.3	larval fish seine
WHB02-112	4			1 June 2002	2.8	larval fish seine
	(2)	14.7 -15.6	postflexion mesolarvae	1 June 2002	2.8	larval fish seine
	(2)	23.5 -24.3	metalarvae	1 June 2002	2.8	larval fish seine
WHB02-118	1	35.8	juvenile	11 June 2002	134.5	larval fish seine
WHB02-121	1	33.1	juvenile	11 June 2002	128.1	larval fish seine
WHB02-126	2			12 June 2002	116.2	larval fish seine
	(1)	29.4	metalarva	12 June 2002	116.2	larval fish seine
	(1)	35.5	juvenile	12 June 2002	116.2	larval fish seine
WHB02-128	1	30.9	juvenile	12 June 2002	109.8	larval fish seine
WHB02-130	2	37.2 -49.0	juvenile	12 June 2002	103.2	larval fish seine
WHB02-133	3	32.4 -43.4	juvenile	13 June 2002	94.0	larval fish seine
WHB02-134	23			13 June 2002	93.0	larval fish seine
	(1)	29.7	metalarva	13 June 2002	93.0	larval fish seine
	(22)	31.5 -55.2	juvenile	13 June 2002	93.0	larval fish seine
WHB02-135	48			13 June 2002	91.6	larval fish seine
	(7)	20.4 -29.0	metalarvae	13 June 2002	91.6	larval fish seine
	(41)	28.5 -53.1	juvenile	13 June 2002	91.6	larval fish seine
WHB02-137	2	37.0 -38.1	juvenile	13 June 2002	84.6	larval fish seine
WHB02-138	14	31.7 -40.3	juvenile	13 June 2002	82.6	larval fish seine
WHB02-139	4	33.9 -52.0	juvenile	13 June 2002	79.7	larval fish seine
WHB02-140	8			14 June 2002	77.1	larval fish seine
	(1)	18.1	postflexion mesolarva	14 June 2002	77.1	larval fish seine
	(7)	34.1 -46.7	juvenile	14 June 2002	77.1	larval fish seine
WHB02-141	1	53.1	juvenile	27 June 2002	75.4	larval fish seine
WHB02-142	2	35.6 -49.3	juvenile	27 June 2002	74.9	larval fish seine
WHB02-146	1	51.1	juvenile	28 June 2002	68.7	larval fish seine
WHB02-148	2	59.5 -62.4	juvenile	28 June 2002	62.3	larval fish seine
WHB02-149	8	41.8 -54.4	juvenile	28 June 2002	61.3	larval fish seine
WHB02-150	1	39.8	juvenile	28 June 2002	60.2	larval fish seine

TOTAL (1998 - 2002) 1,000

Appendix III. Detailed sampling and fish identification protocol.

1. Determination and access to sampling sites

    a. Suitable habitats for larval fish, including areas of low velocity (pools, backwaters, and secondary channels) were identified by field personnel while floating the river.
    b. Access to the habitats was gained via 16' inflatable raft.
    c. River Mile was determined to tenth of a mile using the 1988 aerial photos produced for the San Juan River Basin Recovery Implementation Program.
    d. Geographic coordinates were determined at each site with a Garmin Navigation Geographic Positioning System (GPS) Instrument and were recorded in Universal Transverse Mercator (UTM) Zone 12 NAD27 CONUS. In instances where coordinates could not be obtained due to poor GPS satellite signal, coordinates were determined in the lab using a Geographic Information System based on the recorded river mile.

2. Collection of larval fish samples via seine and associated data recorded

    a. Small-mesh seines (1m x 1m x 0.8 mm) were drawn through the sampling site.
    b. The number of seine hauls per site was recorded along with the length of each seine haul. This information was used to calculate effort (area sampled) using the equation:

    $$\Sigma \textit{ haul lengths (m)} \bullet \textit{seine width (m)} = \textit{effort } (m^2)$$

    c. Ecological data about each site were recorded, including meso-habitat type, length of habitat area, maximum depth, and substrate. A secchi disk was used to determine water clarity. Figure 15 illustrates data recorded at seining sites in the field.

3. Collection of larval fish samples via light-trap and associated data recorded

    a. Light-traps were set only when appropriate aquatic mesohabitats (described above) were located adjacent to that evenings' campsite.
    b. Times of placement and retrieval of the light-trap were recorded.
    c. Ecological data about each site were recorded as above. Figure 16 illustrates data recorded at light-trap sites in the field.

4. Retention, identification, and permanent deposition of specimens

    a. Retained specimens at each site were placed in WhirlPak bags containing a solution of 10% formalin and a tag inscribed with a unique alpha-numeric code that was also recorded on the field data sheet.
    b. Samples were returned to the Division of Fishes, Museum of Southwestern Biology (MSB), University of New Mexico. The specimens were removed from the field bags, debris and silt was removed and they were transferred to glass museum jars containing a solution of 5% buffered formalin. Specimens from each site were sorted and identified to species, then the species series were enumerated, and measured for minimum and maximum size (mm SL) of that sample.
    c. Specimens were identified to species by MSB personnel with expertise in San Juan River Basin larval fish identification. Identifications were made using a polarized, underlit stereo microscope. Specimens whose species-specific identity was questionable were forwarded to Darrel E. Snyder (Larval Fish Laboratory, Colorado State University) for review.
    d. Specimens identified as razorback sucker were further examined for determination of developmental stage and minimum and maximum size (mm TL).
    e. All collections were transferred through a series of 35%, 50%, and ultimately 70% ethanol, catalogued, labeled, and placed on shelves in the in the collection archives of the MSB.

Appendix III. Detailed sampling and fish identification protocol (continued).

Acc 2002 - IV : 22

Field No. WHB02 - 028 (Sample No. two bags)

State or Country: Utah Locality: San Juan River @ RM 76.1

T. R. S. Lat.: Z12 0622629 E Long.: 4124604 N

County: San Juan Co. Drainage: Colorado

Water: backwater on river right

Vegetation: Algae

Temp: 18 °C Air.: 23 °C

Bottom: mud, silt, and some small cobble

Shore: Russian olive & salt ceder Current: ∅ - 0.1 m/s

Dist. offshore: Width: 1 - 9 m Tide:

Depth of capture: ~~larvals~~ .03 - .24 m Depth of water: .03 - .24 m

Method of capture: larval seine

Seine: 1 m x 1 m No. Hauls: 9 Area: 66.8 sq. m.

D.O.: mg/1 Conductivity: µ mhos/cm. ~~Salinity~~ Secchi: .22 m ‰

Shocking seconds: Voltage: Amps:

Collected by: WHBrandenburg & MAFarrington Date.: 29. Apr. 2002

Orig. preserv.: 10 % formalin Time: 1128 - 1158

Lots of fish were collected in this backwater, primarily Cyprinella lutrensis. The down stream end of the backwater is primarily where C. lutrensis was collected. This portion had greater depth than the upstream end and also had quite a bit of inundated debris piles. Most of the C. lutrensis collected were larger fish 40-50 mmSL. A few Catostomid larvae were picked up. None of them were taken in the deeper downstream connection. They were picked up towards the back end in shallower water. Most of the larvae appeared to be Catostomus latipinnis. There was a range of sizes from meso- to meta larvae. One other Catostomid larvae was collected. It was not C. latipinnis it was smaller and had very little dorsal pigmentation (possible Xyrauchen texanus. On the whole few Catostomid larvae were collected. The habitat appeared to be well suited for them. Apparently flows are up since our last trip out (~570 cfs). Main channel temps were lower than that of the main channel (16.5°C). The main channel is also a bit more turbid than last week. Haul lengths were 4.5m, 13.0m, 5.5m, 6.1m, 9.3m, 5.3m, 8.2m, 7.8m, 7.1m

Figure 14. Field sheet used to record seine collection data at a sampling site during the razorback sucker survey in the San Juan River in 2002.

Appendix III. Detailed sampling and fish identification protocol (continued).

Acc 2002-N:22

Field No. WHB02-070 (Sample No. ....)

State or Country: Utah Locality: San Juan River @ RM 116.2

T........ R........ S........ Lat.: 3120672668 E Long.: 4101250 N

County: San Juan Co. Drainage: Colorado

Water: backwater on river right

Vegetation: few inundated grasses & algae

Temp: 24°-16°C Air.: 26.5°C-16°C

Bottom: mud

Shore: salt cedar & Russian Olive Current: ∅

Dist. offshore: Width: 2.7-9.9 m ~~Tide~~ Moon: 1/4 waxing

Depth of capture: .30-.46 m Depth of water: .30-.46 m

Method of capture: light traps n=5

Seine: — No. Hauls: — Area: .... sq. m.

D.O.: .... mg/l ~~Conductivity~~ NA: .... µ mhos/cm. ~~Salinity~~ Secchi: .16 m ‰

Shocking seconds: Voltage: Amps:

Collected by: WHBrandenburg & JPLarson Date.: 16-17. May. 2002

Orig. preserv.: 10% formalin Time: 1946-0806

Five light traps were set in this backwater. Under higher flow condition this area is a short side channel yet presently there is no upstream connection. The downstream connection is broad and shallow. Every trap collected large numbers of larval fishes. The greatest concentrations of fish were collected in the traps that were set towards the terminal end of the backwater. Larval Catostomids were present in four of the five traps (those set towards the back collected the most Catostomids. Hundreds of larval Cyprinids were taken. They dominated in every single trap. The trap set at the mouth produced nothing but larval Cyprinids. Turbidity in this backwater is higher than most of the backwater habitats that we have encountered, I was worried this might affect the success of the traps, but it did not. Visibility was .16 m deep.

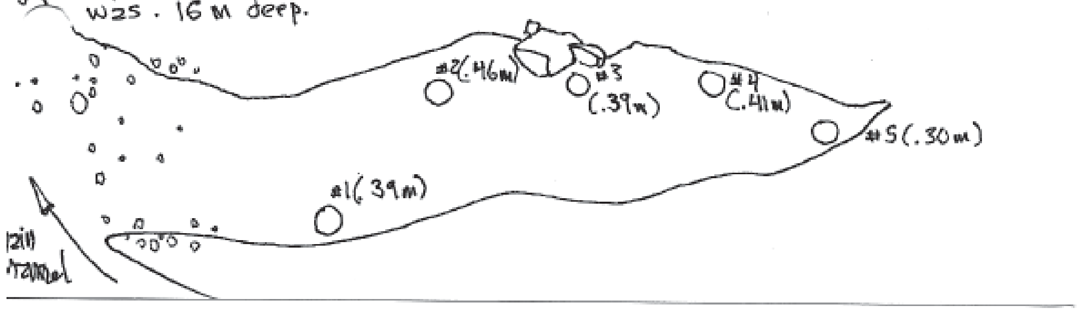


Figure 15. Field sheet used to record light-trap collection data at a sampling site during the razorback sucker survey in the San Juan River in 2002.